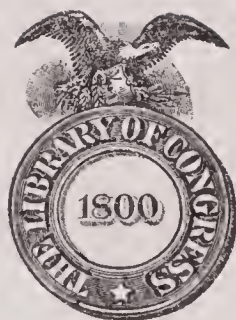


TH 5670

.L16

Copy 1



THE MODERN PRACTICE OF
STAIRCASE AND HANDRAIL CONSTRUCTION,
PRACTICALLY EXPLAINED,

IN A SERIES OF DESIGNS.

BY

MINARD LAFEVER,

ARCHITECT,

AUTHOR OF "BEAUTIES OF MODERN ARCHITECTURE," &c. &c.

WITH

PLANS AND ELEVATIONS FOR ORNAMENTAL VILLAS.

FIFTEEN PLATES.

NEW-YORK:

D. APPLETON & CO.

200 Broadway.

1838.

540690
16

ENTÉRED according to the Act of Congress, in the year 1838,
BY D. APPLETON & CO.
in the Clerk's Office of the District Court of the Southern District of New-York.

8-4172

1053
115

P R E F A C E.

THE non-existence of a work adapted to the use of practical Carpenters, without the addition of much matter which is of but little use to them, and thereby unnecessarily advancing the price, is a sufficient apology for the presentation of this work ; for which selections of the most useful matter are made for practical purposes without useless additions ; and consequently place it within the means of operative men.

No novelties nor new theories are introduced, but constantly keeping in view the immediate demands of the patrons of works of this kind, several drawings are given to very materially aid in constructions in such parts as have previously been overlooked, which frequently causes unnecessary expences and unprofitable applications.

PLATE 1

Is a perspective view of a design for an ornamental villa, which is presented as a model to elicit a spirit for beautiful and original designs.

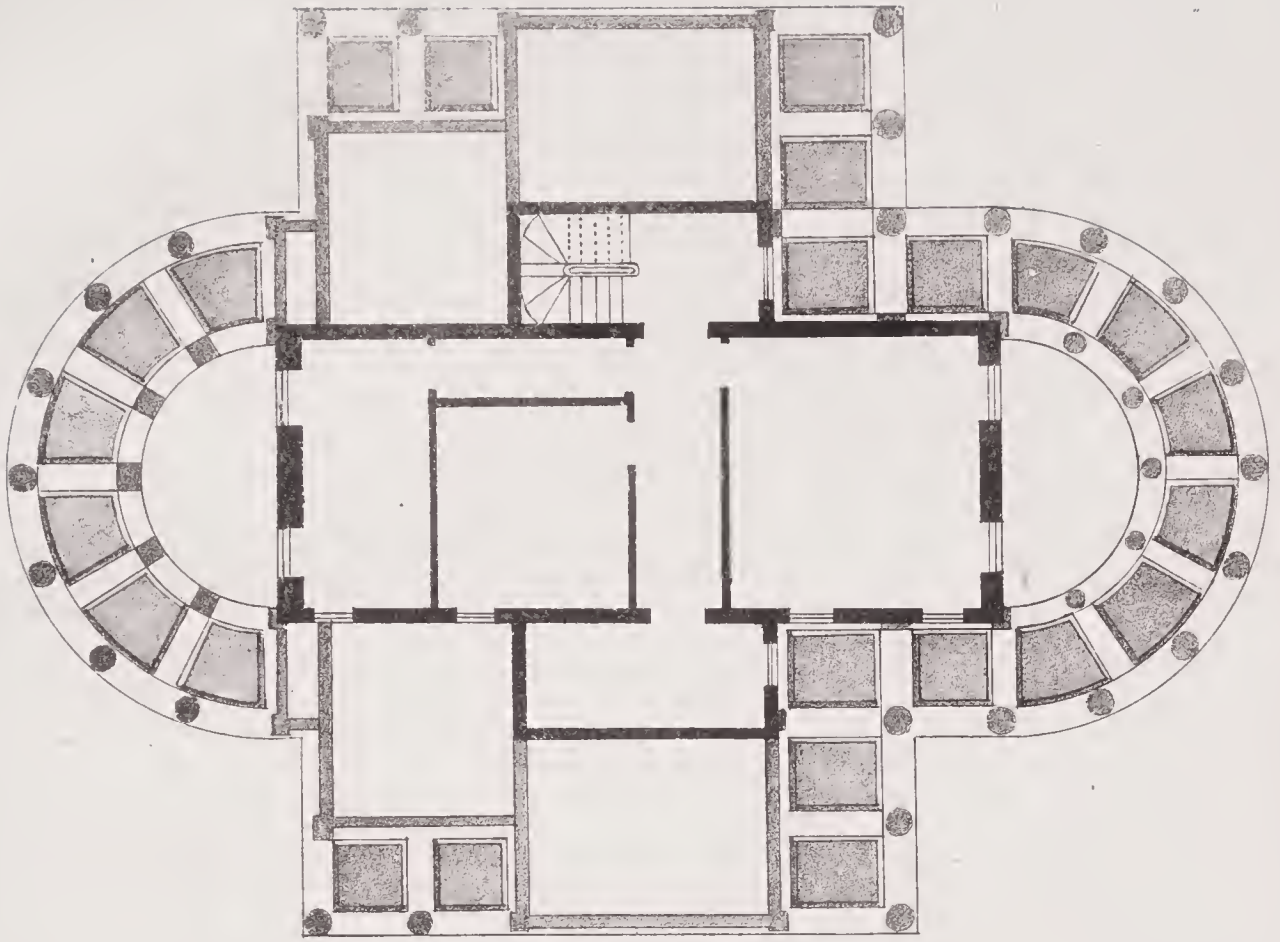




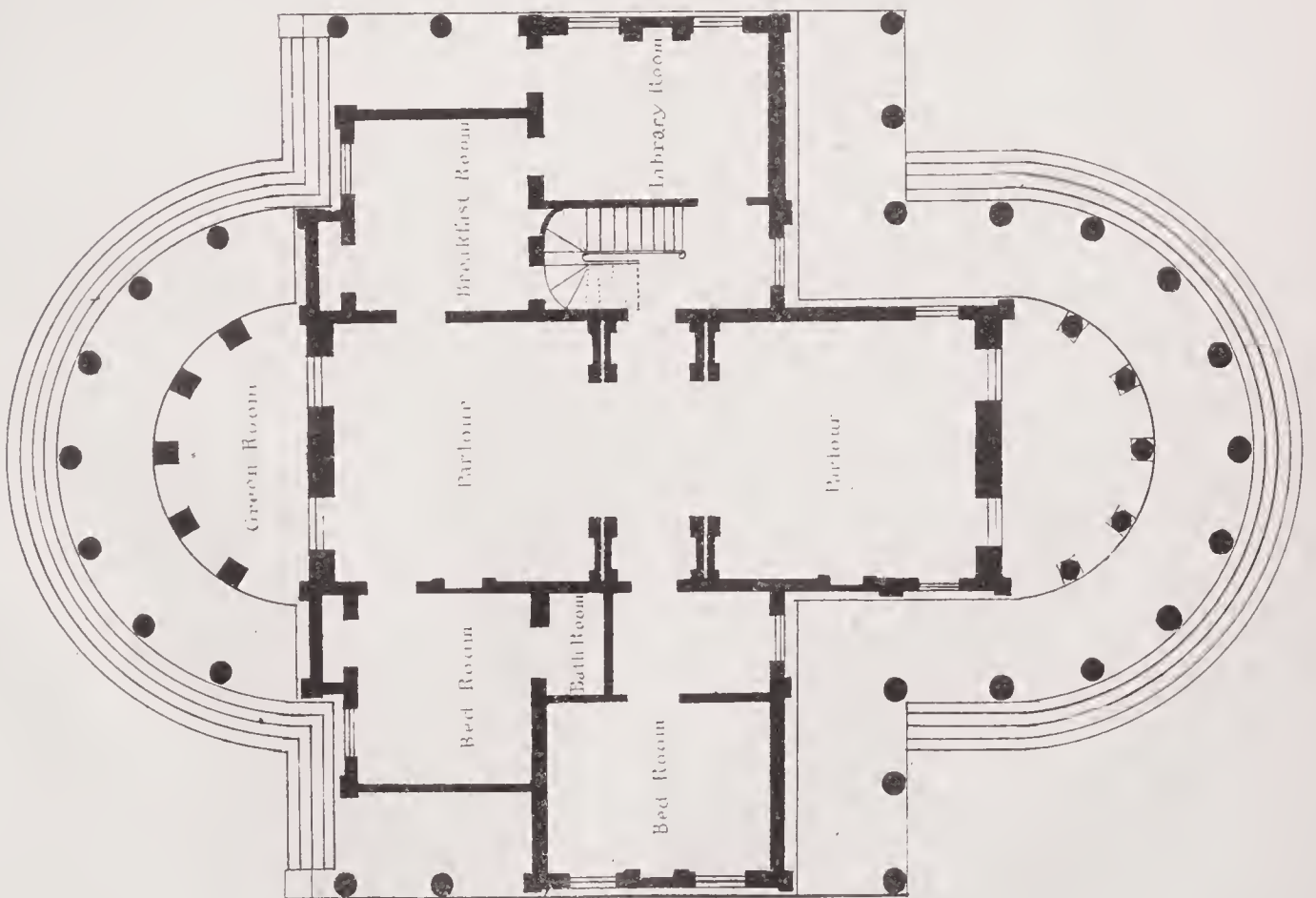


PL. 2.

The ground and second floor plans of Plate 1. This design, as here indicated, is to have the kitchen in the basement ; but should such be objectionable, a kitchen may be very conveniently located immediately in the rear, on a line with the principal floor.



Bufford's Inn, N.Y.



PL. 3

Is a perspective view of a design for a country residence, which presents elegance and conveniencies suitable for a gentleman of respectable circumstances.

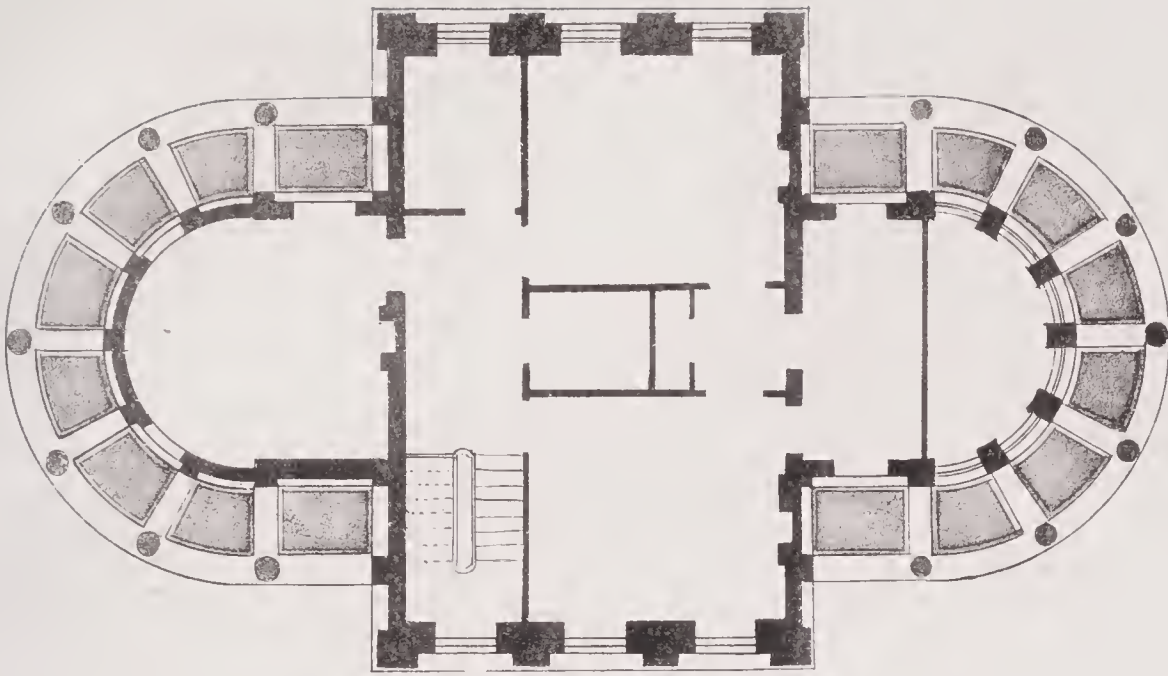






PL. 4

Presents the principal and second floor plans for design Plate 3, and the principal floor plan, as here indicated, is designed to have a kitchen in the basement ; but it may be built with all necessary convenience, on the rear of the plan, and with the use of the floor ; and should such be desired, a plan for such an arrangement would be very readily conceived.



Bufford's Lath N.Y.

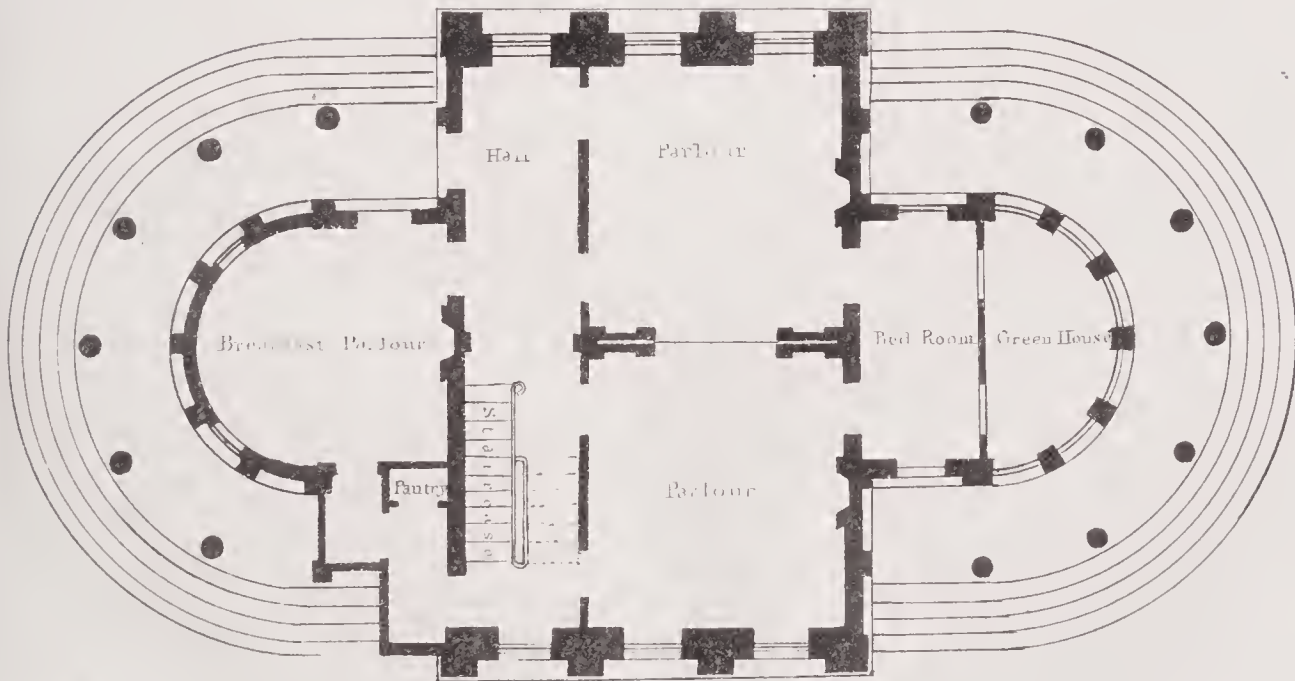


Fig. 1.

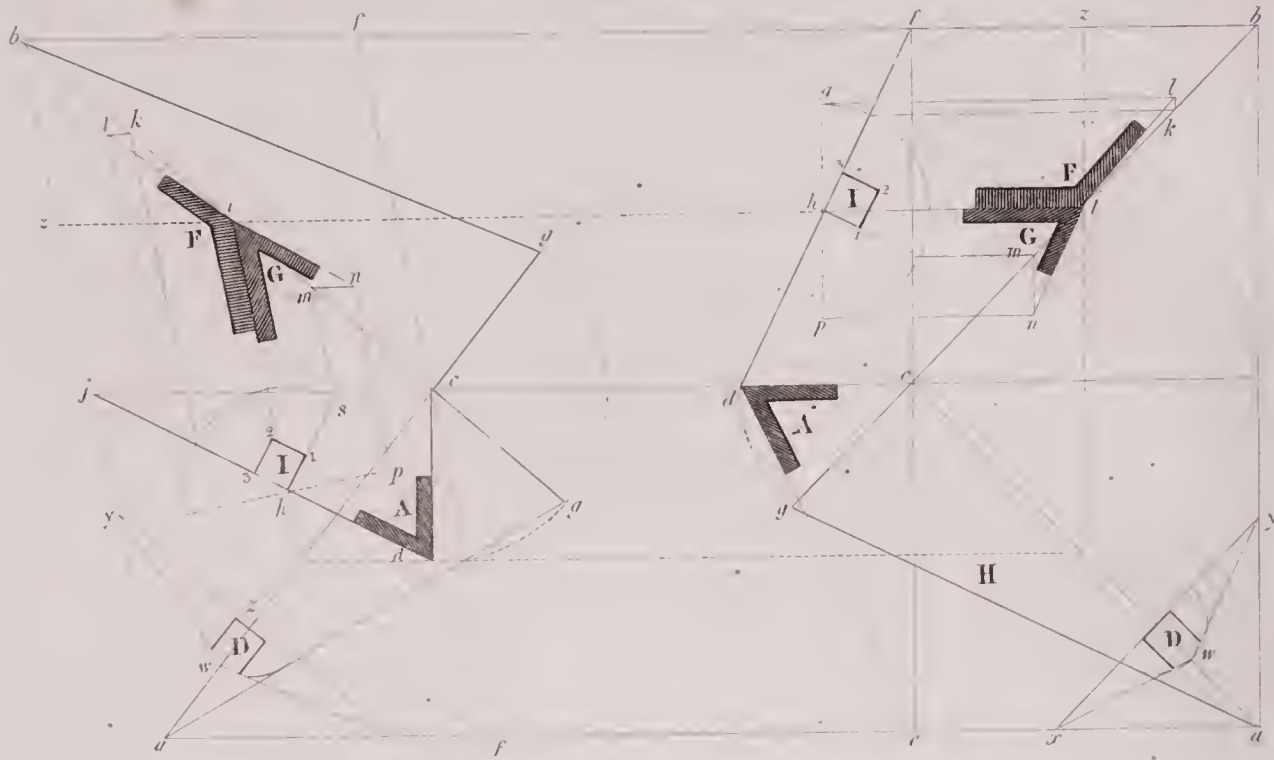


Fig. 2

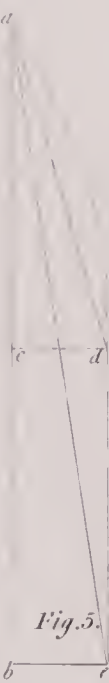
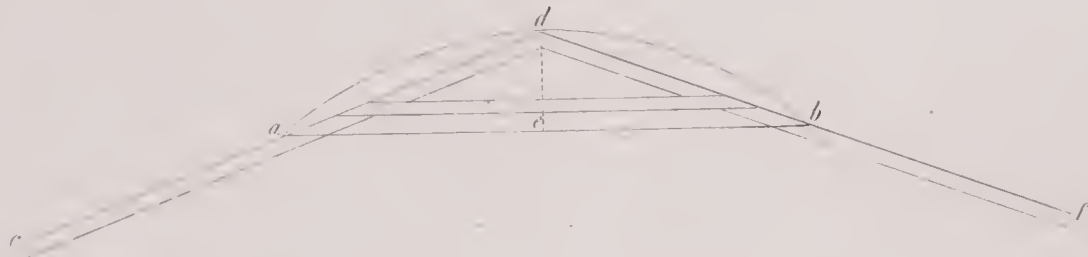
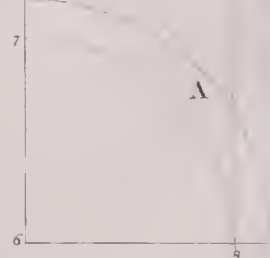
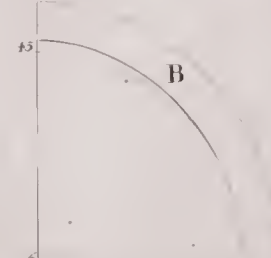
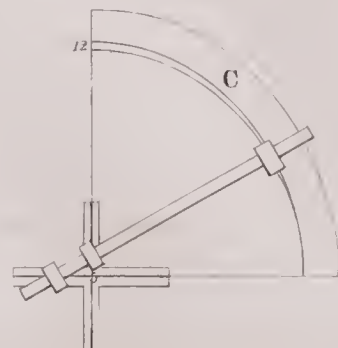


Fig. 3.



PL. 5.

Fig's. 1 and 2, Elevation and Plan of a niche, standing in a wall, with its ribs, for practice, which are obtained thus: draw the given rib A, a quadrant of a true circle, which is equal to the height of the niche in the curve, at 6, 8, in Fig. 1, and equal to the depth 6, 7, on the plan Fig. 2. B and C, jack-ribs, which are both the quadrant of an ellipsis, and have for their plans B C in Fig. 2; the two latter are described with a trammel, as represented in C. The bevel 1, 2, and 4, 5, in B and C, is the same as 1, 2, and 4, 5, in B C, Fig. 2.

NOTE.—The two last ribs will serve as patterns for the two on the opposite side, and save the expense of making expressly for that purpose. For taking distances, and moving the trammel, refer to Fig. 5, Plate XXI. This, however, is guided by pins moving in grooves, which is represented by the large lines in the cross at the rib C.

HIP-ROOFING, FIG. 3.

To obtain the height, length, and backing of the hip-rafter H, *a b f e* being a plan of the right angled ends, let *e c f* be the seat of the common principal rafters, *c d* the height of the roof, and *e d* and *d f* will be the length of the common rafters; raise *g c* equal to *c d*, the given height, perpendicular from *a c*, the seat of the hip-rafter, draw *a g*, and the line *a H g* will be the length of the hip-rafter. To obtain the backing, draw *x z y* at right angles to *a c*, the seat of the hip, place one point of the compass on *z* and describe a circle to touch the rafter, draw *w x y* to intersect the circle and seat *a c* at *w*, and *x w y* will be the planes or backing of the rafter, D will be the shape, and one end of the rafter required.

TO GET THE CUTS OF THE PURLIN TO THE HIP-RAFTER, AND
LIKEWISE THE JACK-RAFTERS TO THE HIP-RAFTERS.

Place the purlin I, at any place in the principal rafter, and at right angles to it, take any distance in the points of the compass, and from the point *h* describe the circle *p s r q*, drop *h s* square from the rafter at the upper side of the plate, drop *p n*, *s m*, *h i*, *r k*, and *q l*, parallel to the wall-plate *f b*, draw *k b* at right angles* to *r k*, and *q l*, draw *i l*, and F will be the side bevel to cut that part *h 3* and *1 2* of the purlin to fit to the rafter; draw *m n* to intersect the seat at *m*, draw *n i*, and the angle round G will be the down bevel to cut the sides *h i* and *2 3* of the purlin; and when thus applied to the end of the purlin, and cut accordingly, it will make a perfect joint to the hip-rafter; turn *a* at the end of F down to the dotted line *z*, and *z i l* will be the side bevel for the jack-rafter to the hip. The bevel A will be the down bevel for the same or jack-rafters.

All that is necessary to say in relation to the opposite end of this plan is, that it is of a parallelogram form, and terminated at its ex-

* It will only answer at right angles when the plan is square, which is proved at the upper end of the plan, which are made parallel to the wall-plates.

tremities by two obtuse, and two acute angles, which consequently require the lines $g l$, $r k$, $h i$, $s m$, $p n$, $l k$, and $n m$, parallel to the side walls $b f$, and $b j a$, in place of at right angles as in the square end. The irregular end has the same letters, and is performed by the same process, but will require it on both rafters, and on both sides of them.

TO DESCRIBE A SEGMENT OF A CIRCLE, FIG. 4, AT TWICE UPON TRUE PRINCIPLES BY A FLAT TRIANGLE.

Let the extent of the segment be $a b$, and its height $c d$; let $a d$ of the triangle be a hypotenuse line to one half the segment, $a e$ a parallel line to $c b$; place a pin at $a d$ for the triangle to slide against, place a lead pencil at d , then move the triangle from d down to a , and one half the segment will be described; and the same process on the other half will complete the segment.

TO DESCRIBE A SEGMENT WITH THREE STRIPS TO ANY LENGTH AND HEIGHT.

Make two rods $e d$, and $d f$, to form an angle $e d f$, so that each may be equal to $a d$ and $d b$; let $c d$ be the height—place pins at $a b$, the extremities—place a pencil at d , then move d round each way from a to b , and the segment will be complete. A segment of this description may be drawn to a great extent with rods, by describing it at twice, as in Fig. 4.

TO DESCRIBE AN OCTAGON, AND RAISE AN ELEVATION FROM IT, AS FIG'S. 7 AND 8.

Draw a geometrical square, as at $a b c d$; place one point of the compass on a , extend the other point to the centre e —let a stand, and describe a quadrant of a circle; proceed thus at each corner, and the plan of the octagon will be at $f f f f$, &c. This method of raising the elevation will be understood by only noticing that the dotted lines are raised from the windows $g g g$, and angles $f f f f$, to the same in Fig. 6.

FIG. 8, TO FIND THE CENTRE OF A CIRCLE, WHOSE CENTRE HAS BEEN LOST.

Let $a b$ be the curve; take any distance, $c d$, and at any place on the curve $a b$, in the compass, and describe the circles $c d e$, $c d e$, and their intersections $f f$ will be direct to the centre, and at the intersection of the two radiating lines at g , will be the centre required; and may be proved by setting one point of the compass in g , and sweeping it round from a to b .

FIG. 9, TO FIND THE MITRE OF A MOULDING IN AN OBTUSE AND ACUTE ANGLE.

Let the plan or shape of the pannel be $a b c d$, draw the inner line of the moulding, which is of the same width all round; draw

d f to cross at the out and inside angles of the moulding, and *d f* will be the obtuse mitre ; and the same process at *a e* will make the acute mitre. The two bevels will be the cut for the templets or mouldings.

Exhibits a plan of groin arches, designed for brick or stone materials, resting on twelve piers, which are represented by the letters A B C D, &c.

It is often the case, that in architectural studies, the student labours under disadvantages at the first examination, for want of references to the different parts engaged in the problems which he wishes to learn; therefore I shall continue to give them in all intricate drawings.

REFERENCES TO THE DIFFERENT PARTS.

A B C D E, &c, plans of the piers.

Fig. 1, Elevation of the centring of the elliptical range, and likewise a sectional view of the semi-circled centres.

Fig. 2, Sections of the covering, or boarding to the elliptical range; (see *o o o o o*, the ends of the boards.)

Fig. 3, Sections of the semi-circle range, and likewise the given height of the groin.

Fig. 4, Is a sectional view of the elliptical centring, and an elevation of the given centre.

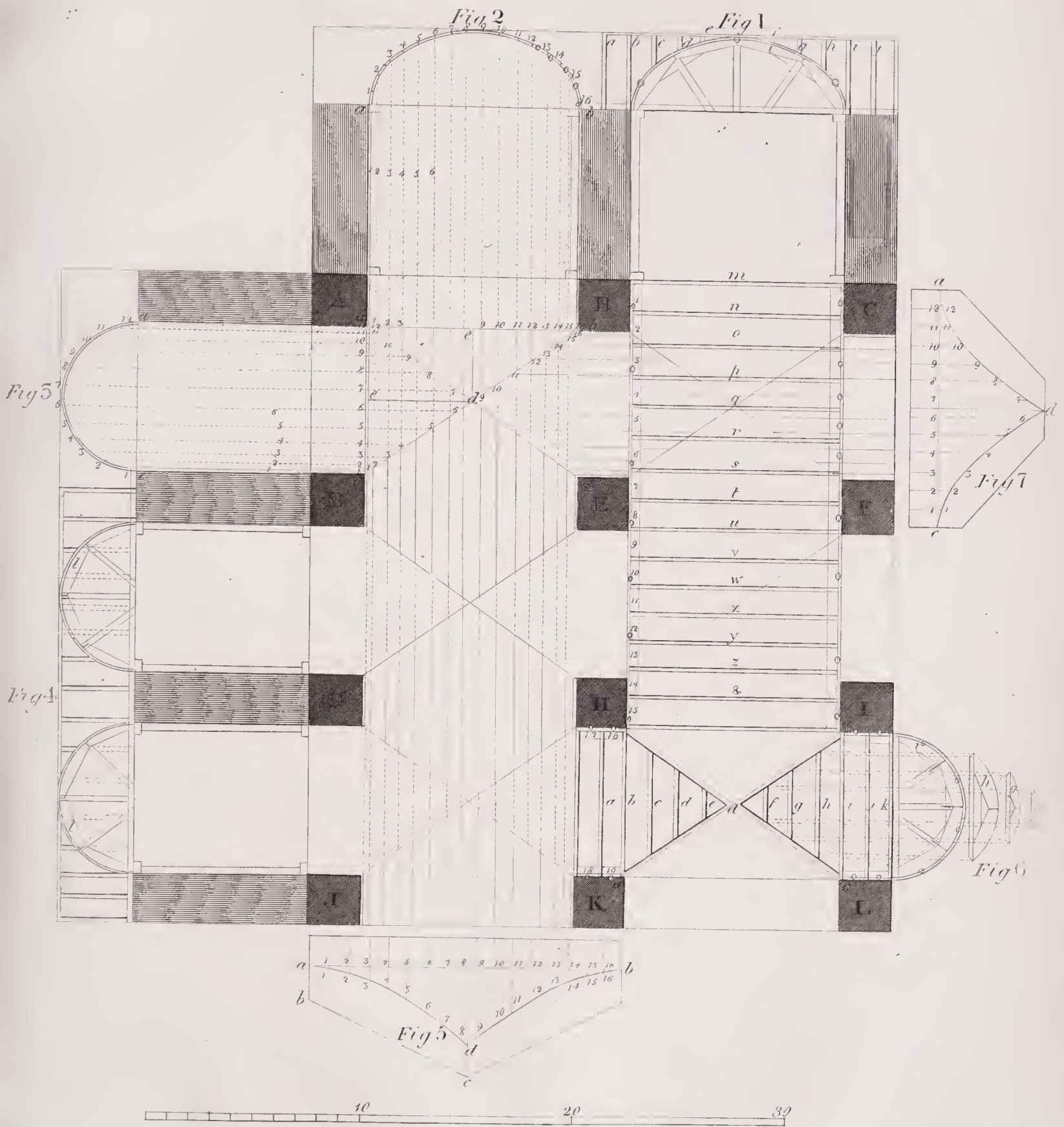
Fig. 5, Is a mould or pattern for determining the groin, or angle of the two ranges.

Fig. 6, Is an elevation of the given rib, or centre, and likewise three jack-ribs.

Fig. 7, Mould or pattern for forming the angle or groin in connection with Fig. 5.

To erect a number of groin arches, the first thing necessary, is to determine the opening and height thereof. For the height, in this example, I have taken a semi-circle for the summit, or given height: now as the given height is of a semi-circle, and much less span than that of Fig. 2, it follows that 2 must necessarily be of an ellipsis.

In the execution of a brick or stone groin arch, it is necessary to erect an entire range of centres, either one way or the other. (In this, I have taken those of the greatest span, which is considered most practical.) It will be seen that one of these openings are covered with boards, and the other has only the plan of the centres, (see *m n o p q*, &c. the plans of the centres,) on which the elevation *l* under Fig. 1 stands. The opening between the piers A B E D G H I and K, which is boarded over, is also timbered the same as the opening between the opposite piers and letters, it being understood that the body ranges or openings are covered with boards or plank entire, from one end to the other. It is next necessary to cover the lesser openings, consequently it will be necessary to obtain the seat of the angle on the covering, to correspond with the angles on the plan at the letters *a b c d*, for which proceed thus: Divide Fig's. 2 and 3 into as many distances as there are boards or plank to cover the same, then drop dotted lines from each joint or board perpendicular to the lines *a b* and *c*, and from thence continue the same line to the diagonal line *a d c* and *a b d*, which has the same figures as





those on the circular line at Fig's. 2 and 3, and are likewise the seat of the groin or angle.

To obtain the seat of the angle on the covering of the elliptical range, get the stretchout of Fig. 2, from *a* to *b*, and place it at any convenient place, say Fig. 5, (see the line *a b* in Fig. 5, which is the envelope,) then take the distance *e d* from the line *a b* from one pier to the other of the capital letters A and B, and set to *e d* in Fig. 5, 5 5, 9 9, &c. and transfer them to the corresponding letters in Fig. 5, and then strike a line through all of those points, and it will produce the necessary line for the seat of the angle on the covering. It will be proper to observe that those parts in the line *a b* Fig. 5, are just equal to the width of the boards in the circle at Fig. 2, for *a b* in 5 is the envelope of 2.

To apply Fig. 5 to the covering, first, it is understood that Fig. 2 is the covering: accordingly it will be proper to suppose Fig. 2 standing on the level *a b*, and also underboarding; hence it is evident that if the pattern at the letters *a c b d* are bent over the boarding at *a c b d*, and marked round accordingly, it will produce the seat of the angle required; to obtain the opposite, just reverse the pattern. I have also given Fig. 7 to bend over Fig. 3, which is obtained by the same process, and likewise applied in the same manner. This, however, is more essential to cut the ends of the boards to joint on to the body range, than for any other purpose. To cut the boards, it will be observed, that the distances marked in Fig. 7 are equal to the boarding in Fig. 3; therefore, if they are cut according to the circles *c d* and *a d*, they will make a perfect joint to the boarding of the body range.

Fig. 6 is an elevation of one of the semi-circled centres and their jack-ribs, (see the sections at Fig. 1,) *f* at Fig. 6, is an elevation of *f* in Fig. 1, *g* and *h* in Fig. 6 are also elevations of *g* 6 in Fig. 1. It will be understood that *f g h* in the plan, are the seats of the jack ribs *f g h* in Fig. 6; and likewise, that *f g h* will set on the circled sides of the body range, consequently they will require beveling. The bevel may be obtained by applying to the sections *f g h* in Fig. 1, where the bevel may be seen at the seat of each section.

REFERENCES TO THE SMALL LETTERS.

l, in Fig. 1, represents an elevation on the elliptical centre.

o o o, in *l*, represents the boarding.

m n o p, &c. represents the plans of the centres, (see *l*, elevation of centre.)

o o o o o, long side of the piers C F I, represents the boarding.

a b c e f g h i j k, plans. The same letters in Fig. 1, and also in 6.

1 2 3 4 5, &c. by the side of the piers B E H, represents the plates.

NOTE.—It may be understood that *a b c d*, at Fig. 5 will answer the same purpose as *a 8 d* in Fig. 5, for they precisely fit each other.

PL. 7

Is a plastered groin arch designed for an oblong ceiling, and represented at its angles by the letters A B C and D. The angle or groin ribs in this example, are all connected at the centre of the ceiling; consequently it may be termed an entire groin ceiling—whereas, if any part of the horizon or centre was horizontal or level, it might be termed a groin ceiling with a horizontal centre, which is often the case, and affords room for ornamental centre flowers.

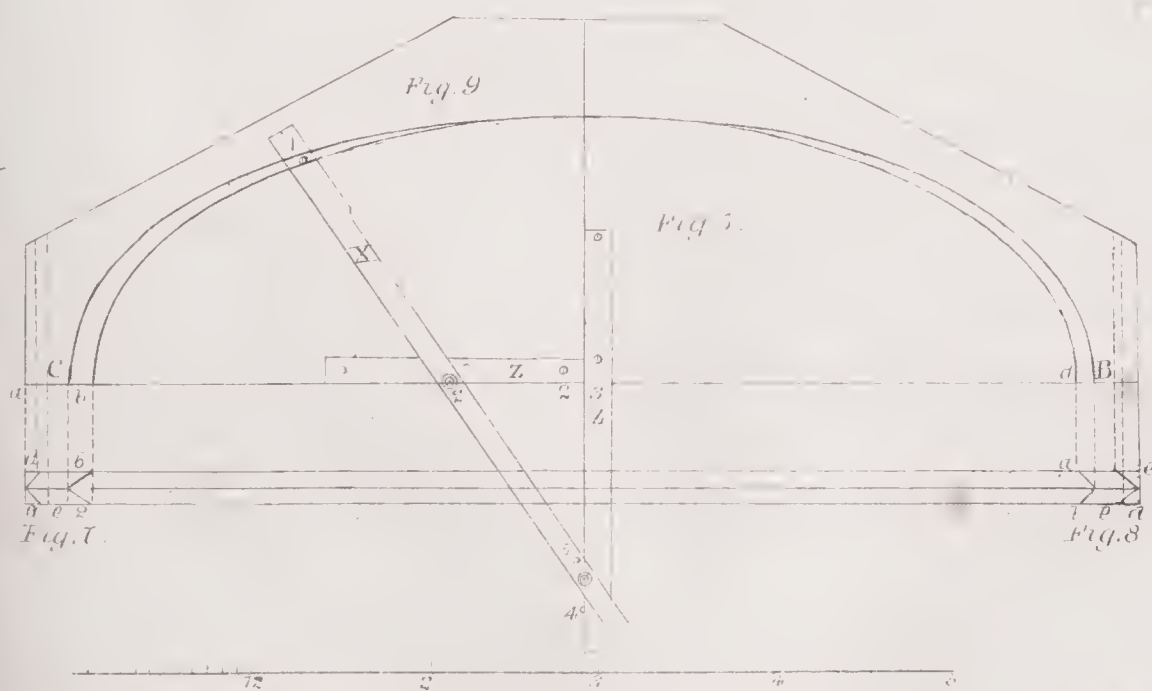
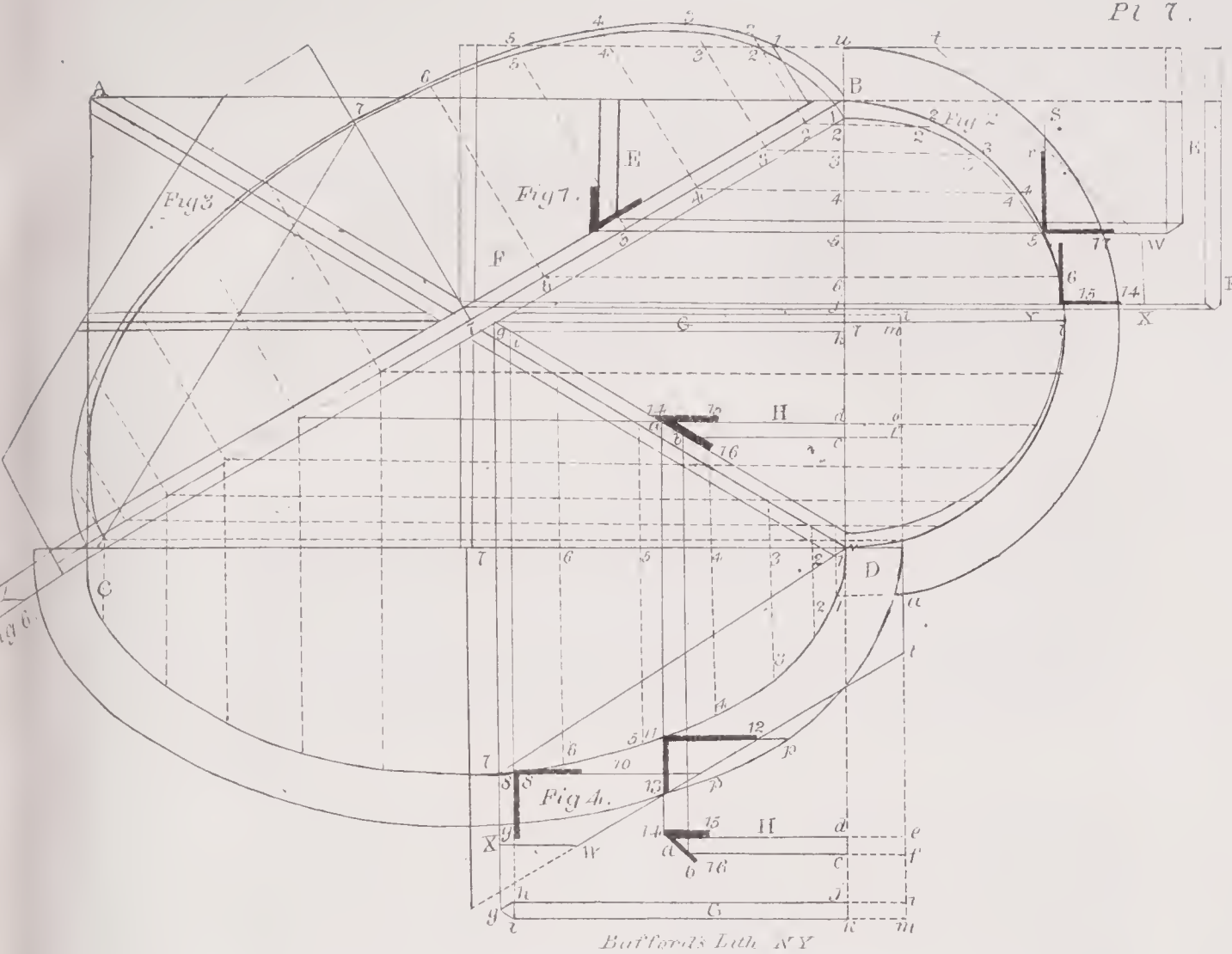
This design may be executed of one, or one and one quarter inch boards.

NOTE.—It would not be unsafe, to execute a ceiling of this kind, of $1\frac{1}{4}$ inch plank, over a span of from 30 to 40 feet, if care should be taken in the execution to avoid splits, by nailing in improper places.

TO DRAW THE RIBS TO AN OBLONG PLAN.

First, determine the height of the ceiling in the centre. In this design, the groin rib at Fig. 2, is a semi-circle; consequently it raises one half of the conjugate diameter, (that is, one half of the smallest span,) and thus the given rib being a semi-circle, the transverse and angle rib required, will be a semi-ellipsis, which may be drawn by two methods. In this example I have given both; one by transferring lines from the given rib Fig. 2, capital F, to the other two ribs, capital F, Fig. 1 and Fig. 4, which is both tedious and incorrect in practice; the other is drawn by a trammel and two strips of wood, and represented at Fig. 5.

The groin rib being got, at Fig. 2, proceed to draw Fig. 1, the angle rib. First, divide the semi-circumference into any number of equal parts, say seven; then drop lines from 1 2 3, &c. perpendicular to the base line B D, to intersect 1 2 3, &c.; then let the same lines extend to the figures 1 2 3, &c. on the base of the angle rib, Fig. 1; draw 1 1, 2 2, 3 3, &c. at right angles to the base line B D; take the distance 1 1, in Fig. 2, and transfer it to 1 1, in Fig. 1, and so also 2 2, 3 3, &c. to the same figures in Fig. 1; and by tracing round by 1 2 3 4 5 6 7, one half of the angle rib will be produced: and to obtain the other half, proceed the same way. The angle rib being drawn direct from one angle of the ceiling to the other, (that is, on the middle and thick line between B and C;) it will be observed that the outer edges of the rib will not be in range with the body range, and will not be so convenient to nail the ends of the lath: therefore, in order to make the groin perfect, it will be necessary to make the angle ribs to accord in shape with Fig's. 6, 7 and 8. It will also be observed, that the angled recess in Fig's. 6, 7 and 8, are not the same distance in from the two extreme points, which is produced by the plan of the groin's being of an oblong figure; whereas, if square, (that is, the same size on all four of its sides,) it would be the same. It will be further observed, that it requires more on the side C, than on the side B, which is likewise caused by C being on the side, and B on the end.





TO PRODUCE THE INNER CIRCLE THAT JOINS ON THE SIDE AT C, AND END AT B.

First, draw the lesser or inner circle, under Fig. 2, the given rib; then take the shorter distances 2 2, 3 3, &c. in Fig. 2, and transfer them to the same figures in Fig. 1; trace round as above described for the outer circle, and the circle required to correspond with the angle and body, will be produced.

TO SHOW THE METHOD OF CUTTING THE BODY RIBS, TO JOINT WITH THE ANGLE RIBS.

First, determine the location of the ribs, say at E F G and H; then raise two perpendiculars from the letters *j i*, in G, to cross the rib Fig. 4, which, when raised up, will range directly over G; then draw the lines *y p*, parallel to the base line C D; now take the square and apply it to the Fig's. 8 9 10; then scribe across from 8 to 9, and the plumb-cut required will be produced. To get the cut at the joint, just slide the square out to *x y*, which will give the cuts required. Proceed the same way down at the square 11 12 13, for the rib H.

TO CUT THE JOINT, JOINING ON THE SIDE OF THE ANGLE RIB.

Take the bevel 14 15 16, and apply it to H, the plan of the rib, and join the blade 14 16, to the plan of the angle rib A D; then take the bevel and apply it to H, directly over the rib Fig. 4, which is the same length of the shortest rib, (see the letters *a, b, c, d, e, f*, in H A, which shows that if the shortest, rib in Fig. 4 is raised perpendicular and set over the plan H, would be in its practical position, and also joint to the angle rib.) It must be observed that the stock of the bevel must lay on the line 11 *q*, which is parallel to the base, and by applying the stock thus, the blade will not lay flat on the under side, but will only touch at the lower and opposite corner, but at the same time when thus applied and cut accordingly, the joints will be perfect.

REFERENCES TO THE FIGURES.

A, B, C, D, plan of the groin.

Fig. 1, Elevation of the angle rib.

Fig. 2, Elevation of the given rib across the smallest span.

Fig. 3, One half of the angle rib in the shape when cut out of the board.

Fig. 4, One half of the transverse rib, or rib over the greatest span.

Fig. 5, An Elevation of the single rib drawn by a trammel.

Fig's. 6, 7, 8, plan of the angle rib at its butments.

t, u, v, w, x, y, represent an elevation of the rib, Fig. 2, when cut out of the board, and likewise are the same at Fig. 4, in the transverse rib.

E F G H, ground plan of the ribs. In will be noticed that E F

G H are placed over the elevation of the ribs, which is done for the purpose of conveying a proper understanding of them.

a, b, c, d, e, f, in G H, over the elevation, will correspond with the same G, H, in the plan.

14, 15, 16, bevel applied.

8, 9, 10, square applied to the horizontal *y, p*.

11, 12, 13, square applied to cut the joint of the short rib, to the angle rib.

TO DRAW FIG. 5 WITH A TRAMMEL.

First, draw the line C B, the base line of the angle rib Fig. 1, in the plan; then get the centre of C B, and raise a perpendicular therefrom equal to 7 7, the height of the ceiling at the given rib, Fig. 2; then take the height 7 7, and apply it to the trammel at 1, on the circle of the ellipsis, and 2, on the base line; then the distance 1 2, on the trammel, will be just equal to 1 2, in the perpendicular lines at the centre; then take the semi-transverse diameter of the line C B, which is from C to 2, and apply it to the trammel from 1 to 4, which is also placed on the perpendicular line 1 4; now suppose the trammel first located perpendicular, and 1 4 of the trammel would be equal to, and on 1 4 on the perpendicular line. The trammel or strip being thus placed, fix brad-awls in 2 and 4 in the trammel; the black dots represent the awl, and the outer circle the handle to the awl, to secure the strips *z z*; if for a large span, they may be screwed on, and if for a smaller span, brads or small nails will answer. To describe the circle from 1 at the centre in the horizon, round to C, at the base of the rib, suppose the trammel *x*, to be placed perpendicular on 1 4—apply a lead pencil to the hole at 1; then move the trammel *x* round from 1 to 2, minding at the same time to keep the brad-awls at 2 4, snug to the strips *z z*, and one half of the rib will be complete. For the other half, if made in two pieces, take the half already obtained, and use it for a pattern thereto; but if required in one entire rib or piece, the two strips *z z* should be reversed; then move the perpendicular piece on the opposite side of the centre line, and the horizontal piece directly under Fig. 5; for to describe the ellipsis, proceed as in the above already drawn, and the circle C 1 B, will be produced.

DESCRIPTION OF THE INNER CIRCLE.

First, it will be observed that the circle *b 1 d*, is a trifle to the right of the centre, which is caused by the plan of groins being of an oblong square; (see the plan of the rib from C to B; and the greater difference will be understood to proceed at C, from its sitting on the longest side; and at the opposite angle at B, from its sitting on the shortest side of the plan.) To make the thing easily understood, a plan of the buttments is given at Fig's. 6, 7 and 8, represented by the letters *a b c*—which will show that this difference will be right—the reverse on the opposite side. This inner circle is drawn the same way as that of the outer, with no other alterations

than to take half the distance $b d$, which is at 3, on the opposite side of the line from 2, and set it on 5 on the trammel, just above 4. Now proceed the same way to describe the ellipsis as above directed; for the outer line thus far, produces one side of the angle rib.* For the opposite side, the one obtained may answer for a pattern.

NOTE.—The transverse is drawn the same as that of the angle rib, and is generally represented first, which is, however, a matter of no difference, for they are of the same height in the centre of the ceiling. Further—if the ribs are drawn and cut as herein described, and executed accordingly, it will produce a perfect groin ceiling.

* This angle rib is made of two planks or boards, as occasion may require, and when cut and put together as here represented, will form a complete angle rib. (See the Fig's. 6, 7, 8.) At the centre it will be square.

PL. 8.

In this Plate are two scrolls described by the same rule and centres, but have different proportions.

These two examples are given in order to show that a scroll or spiral fret may be contracted by making the centres smaller, and extended by making them larger.

REFERENCES TO THE FIG'S. 1, 2, 3, 4, 5 AND 6.

Fig. 1, A scroll of one revolution and three quarters, drawn by six centres got by dividing a geometrical square into 36 equal parts.

Fig. 2, An elevation of the wedges to strain the veneer round the block under the curtail step.

Fig. 3, A part of the riser and veneer, (see riser and veneer in Fig. 1.)

Fig. 4, Plan of a revolution, and a half scroll.

Fig. 5, Pitch board.

Fig. 6, Face Mould.

NOTE.—In Fig. 1, I have likewise described the block and curtail step, which will be explained.

TO DRAW THE SCROLL IN FIG. 1.

First, draw a circle (generally called the eye,) $3\frac{1}{4}$ or $3\frac{1}{2}$ inches, (in this it is $3\frac{1}{4}$;) then draw a geometrical square equal to one half of the eye—divide the geometrical square into 36 equal parts or squares, and at the same time extend one of those parts out to 6; now draw the spiral lines—set one point of the compass on 1, one square from the centre *o*, and extend the other point down to *o* on the edge of the eye—let 1 stand, move *o* round to 1; let the outer 1 stand, extend the inner 1 out two squares to 2; let 2 stand, move 1 round to 2: let the outer 2 stand, move the inner 2 down to 3, move 2 round to 3; let the outer 3 stand, move the inner 3 out to 4; let 4 stand, move 3 round to 4; let the outer 4 stand, move 4 out to 5; let 5 stand, move 4 round to 5; let the outer 5 stand, move the inner 5 out to 6; let 6 stand, and move 5 round to 6, and the convex side of the scroll will be complete. To describe the inner or concave side, follow the same figures back—that is, after setting the width of the rail in at 6 6.

TO DRAW THE BLOCK AND VENEER FOR THE CURTAIL STEP.

First, set back from the front of the rail at *b*, Fig. 1, to *I*, one half of the projection of the nosing, which will be the front line of the bracket or front string; then draw the line *I J M N P*, by following the same centres of the rail, and the concave side of the block will be produced. For the veneer and convex side of the block, set one point of the compass in 5, and extend the other point out to *K*; let 5 stand, move *K* round to *L*, and so round until the line or veneer meets the letter *A*—which is the end of the veneer let into the block from *P* to *A*, by running in the cut of a pannel saw.

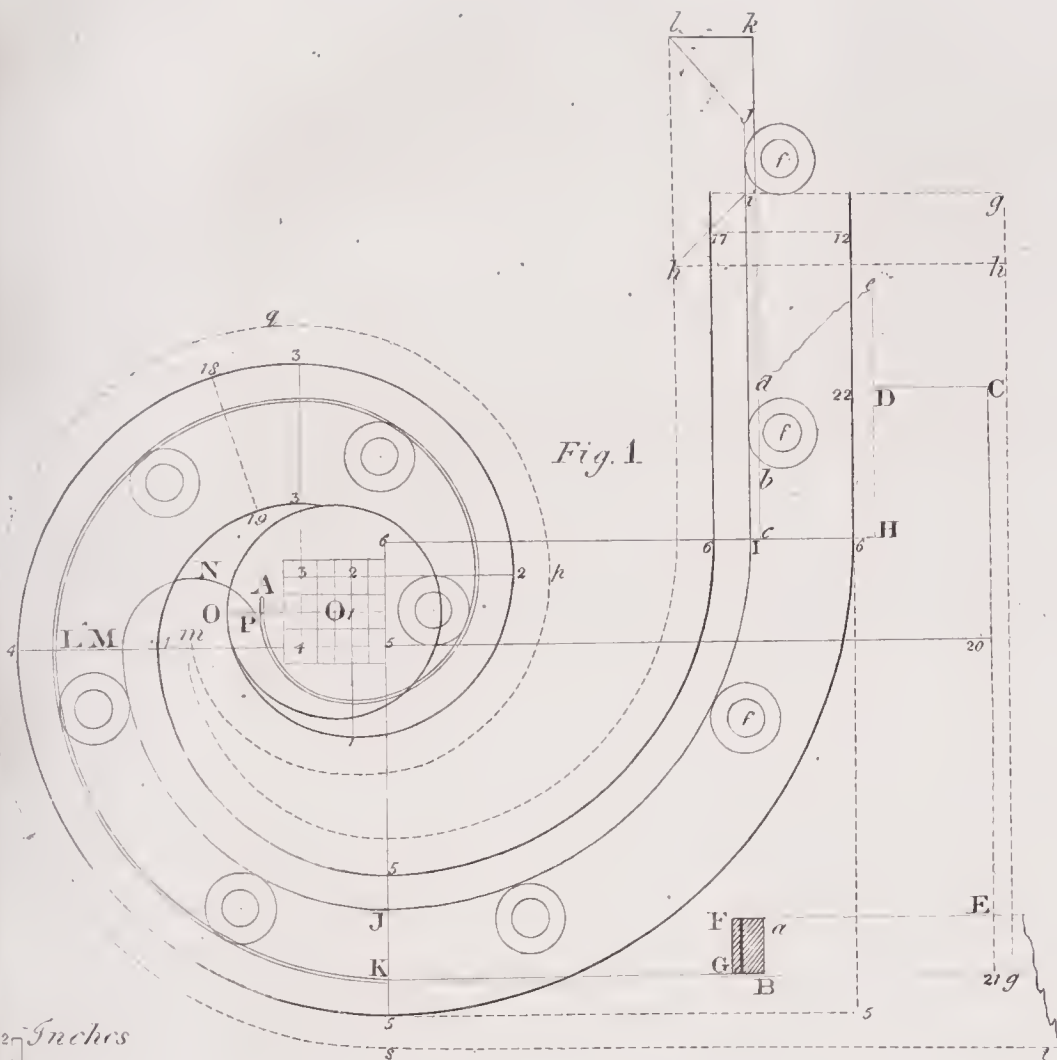
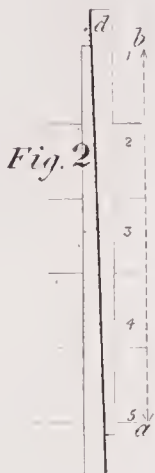


Fig 3



12 Inches

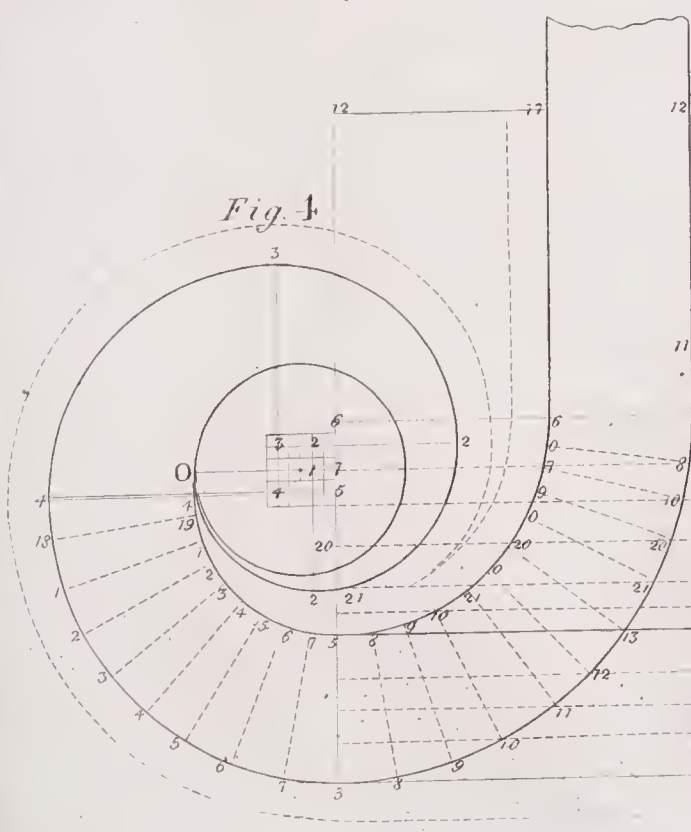
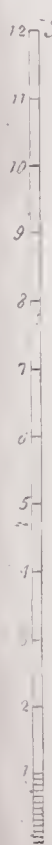
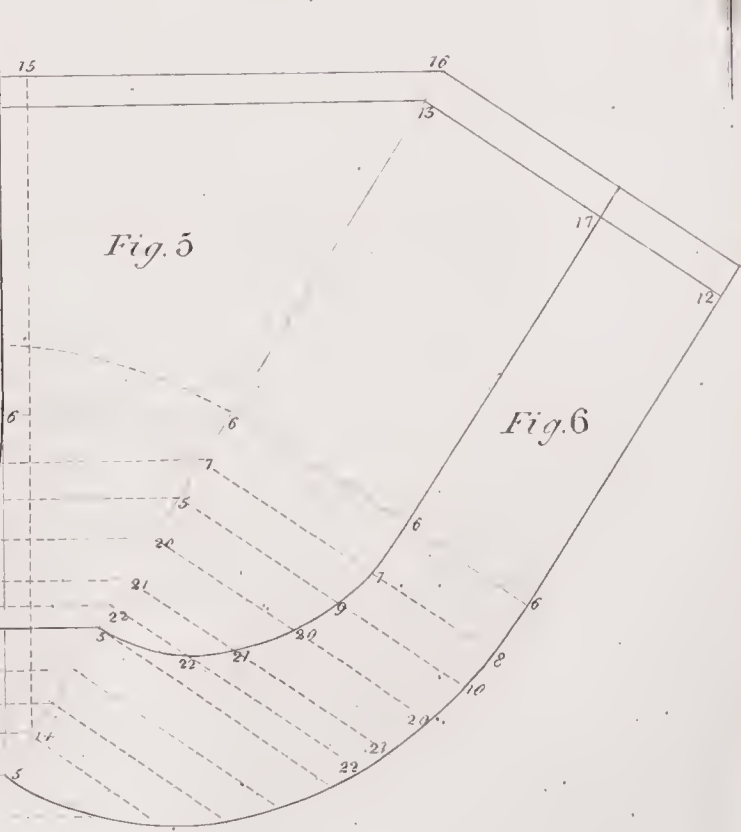


Fig. 5





TO FORM THE BLOCK, AND WORK IT OUT.

In order to secure the block from shrinking and breaking apart, it is necessary to glue it up into about five thicknesses, (see Fig. 2, the riser.*) These thicknesses must be equal in width to the line L 20, (that is, the ones that lay across the step,) and those that run lengthways the step, equal in width to the line C 21. To prepare the block for the reception of the front string and bracket, cut the gain I H D, noticing that the junction of the string and block is at I; the letter *b* is the bracket, and *c d e H* a part of the front string; from the bracket, it will be understood that the block is made sufficiently smooth round to P, not to require any veneer. To get the length of the veneer, take a small cord or twine, and apply one end at the end of the veneer at the letter A—then encircle the block from A round by L K to G, which will be the length of the veneer required; then calculate whatever thickness for the wedge may be thought proper; (in this it is one half of an inch)—from that to one inch is proper. It will be understood at the same time from Fig. 3, that the lower riser must be in the same piece with the veneer.

TO PREPARE THE RISER AND VENEER.

First, get the length as above described, then guage the veneer at B about 1-8th of an inch thick; then take a rip saw and cut the veneer from A to B, plane it up without the least variation that can be seen, crossways, giving it a gradual diminish from B to A, so that A may enter the cut of a pannel saw; then prepare a quantity of hot water and put the veneer into it, and there let it remain until it becomes as soft as a piece of leather. Prior to this, take a sizing of glue and size the block, and let it get dry before the application of the veneer—and at the application give it another good coat of well-prepared glue. Then take it and place the end perfectly square into the saw cut at A, and gradually bend it round the block, until it will admit of the riser's fitting in the block at E, minding to have it well glued at the same time; then take the wedges at Fig. 2, and drive one from the upper side and one from the under side, and the wedges being properly drove, will strain the riser smooth and snug to the block. Care must be taken to have the veneer lay snug to the block from K to B, which may be effected by placing the block in some proper place and applying a flat piece across it, and secure it by a weight or some other means, in which place it should remain until it becomes perfectly dry.

TO DRAW THE CURTAIL STEP.

In Fig. 1, the dotted lines represented by the letters *k l h n*, &c. is the outer line of the nosing of the curtail step, and is drawn by the same centres of the rail.

* And wedges to strain the veneer.

The dotted line *g g* at the right hand, is the width of the tread of the step from the first rise to the second ; 5 12 is likewise the width of the step ; *h h*, nosing of the second step ; *g i*, second riser ; *j l k* is the return of the nosing round the bracket. In this plan, I have extended the nosing over the bracket, equal to the size of the bannister, which is not practised by all stair builders, though to me it appears most mechanical.

TO DRAW THE SCROLL FIG. 4.

Draw the eye or circle $3\frac{1}{4}$ or $3\frac{1}{2}$ inches, then draw a geometrical square in the centre, equal to one-third the diameter of the eye, and for the other parts, proceed precisely as in Fig. 1.

TO DRAW THE FACE MOULD FIG. 6.

Take the pitch-board Fig. 5, and apply the base line 5 12 to the convex side of the rail or scroll ; then draw the ordinate lines 6, 5, 6, 6—7, 7, 8, 7—5, 9, 10, 5, &c. perpendicular to the base or under edge of the pitch-board 5 12, and extend them up to the hypotenuse or rake line 5 13, to intersect the figures 6, 7, 5, &c., then take the distance 6, 6, 6, from the line 5, 12 across the eye of the scroll in the point of the compass, and transfer them to 6, 6, 6, in Fig. 6, (noticing that the ordinates in 6 are drawn at right angles to the rake of the pitch-board.) Proceed the same way with 7, 5, 20, 21, &c., and then trace round from 6, 6, to 5, 5, and the size and shape of the face mould will be produced. Now to understand the practical position of the face mould, Fig. 6, suppose the pitch-board, Fig. 5, to stand on the line 5 12 across the eye—then it will be understood that the line 5 13 of the pitch-board is the rake of the stairs. Now, if the student observes with attention the pitch-board standing as above placed on the line 5 12 across the scroll, he will see that the face mould, Fig. 6, will range precisely over the corresponding one in the plan of the scroll, Fig. 4.

NOTE.—The letters *fff*, &c. Fig. 1, represent the bannisters.



Fig. 2

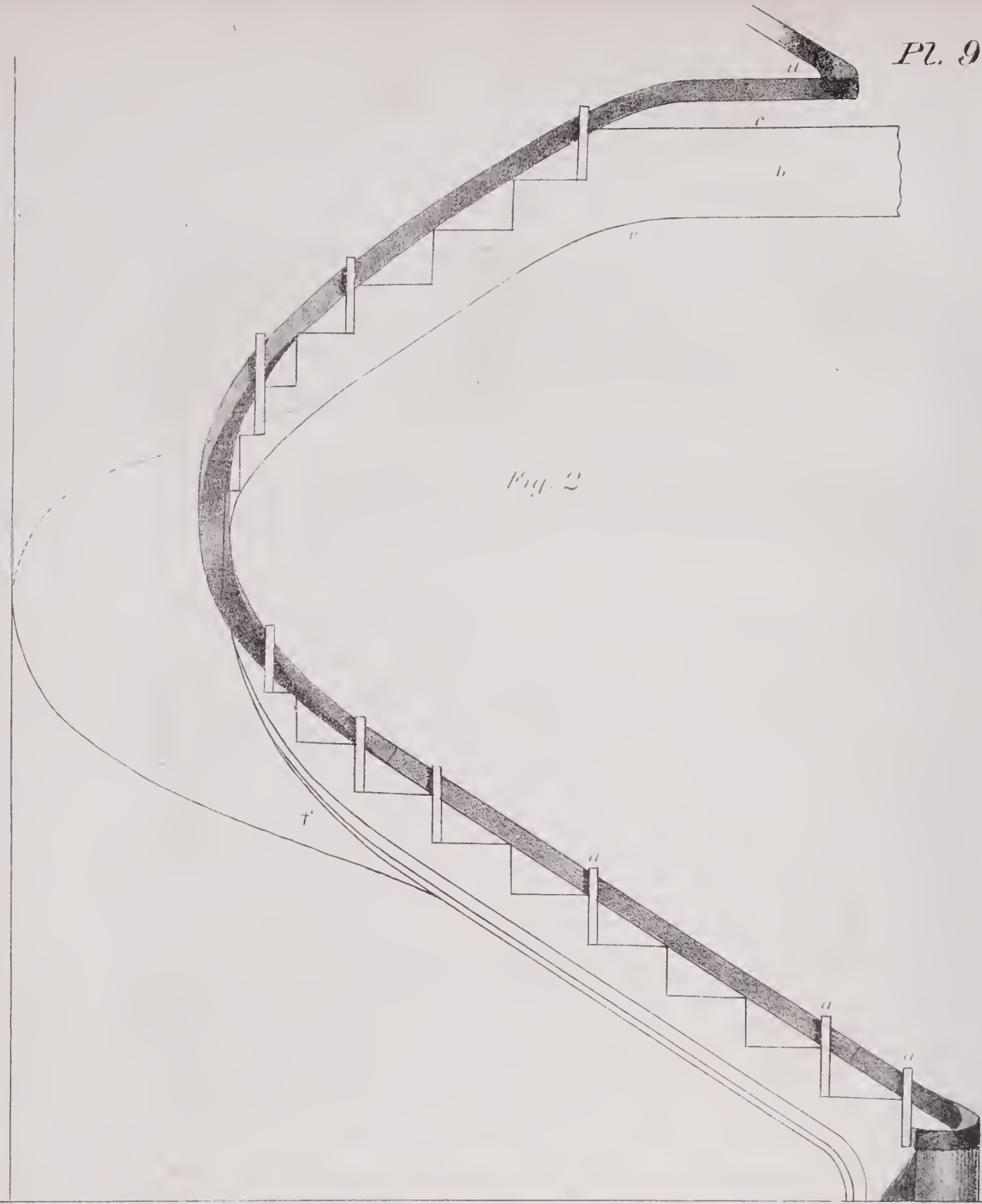
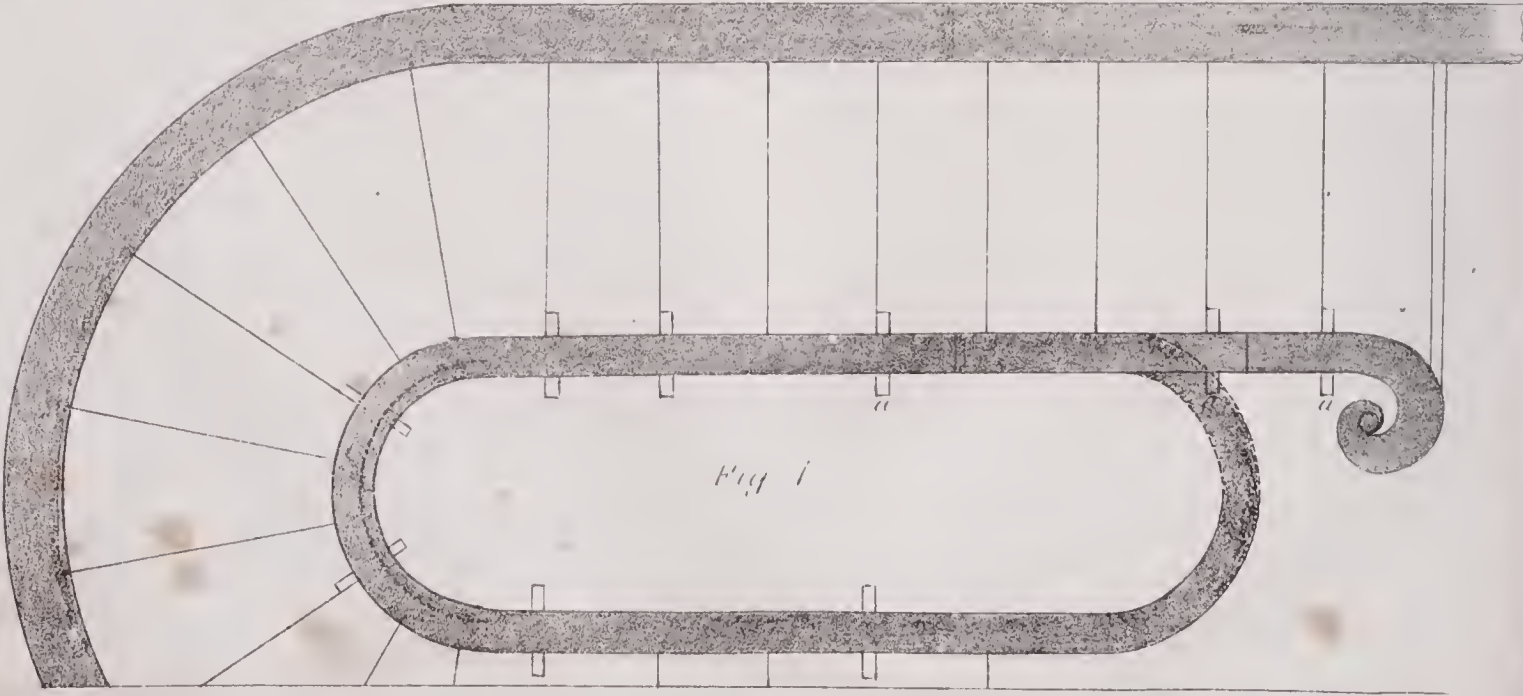


Fig. 1



PL. 9.

This Plate is introduced to show the method of applying a hand-rail to the stair previous to cutting the joints, or bringing the rail to its uniform size and form, which is the course pursued at present by the most experienced stairmen, and by whom the most perfect rails are executed. The application is as follows:—First, make the brackets *a a a*, as in Fig's. 1 and 2, and fix them to the stair as at *a a a*, the plan Fig. 1; the bracket *a* is cut open in the middle sufficiently wide to admit the rail to move either way, as required in securing it by wedges for cutting the joints, and preparing the rail at several points to a proper size: after which, the rail may be taken to the bench and prepared for placing upon the ballusters.

The executor should be very particular in forming the easings in the strings and rails; for in that portion the entire elegance is dependent: and to produce which, the easings must be formed so as to intersect with the straight parts perfectly easy to the eye, and at the same time to form the curve or circular part, so as not to fall too low; for such would produce as unpleasing effect as short and abrupt easings; it is therefore important that the executor's judgment be properly exercised on this important part of his profession. The following are the parts described on the Plate:—

Fig. 1, Plan of the Stairs; *a a a*, the brackets as in elevation, Fig. 2.

Fig. 2, Elevation showing the application of the rail when fitting the joints and easings as above described; *a a a*, the brackets to support the rail as above; *b*, a portion of the string joining to the second floor; *c*, second floor, *d*, the turn of the rail at commencing to ascend the second story flight; *e*, the easing between the ascending and level parts of the string; *f*, the under line of the string, and that portion of the soffit or ceiling, that envelopes the winding and circular part of the stairs.

With the above explanation and the accompanying drawing, the executor will be prepared to investigate every part of the subject, so as to enable him to perform in execution the most difficult and intricate parts in this branch of his profession, with a greater degree of perfection than by the stiff and arbitrary method of *lines exclusively*, that are laid down in the many excellent works at present extant.

It may be important further to advise the ingenious young operator not to fancy that his knowledge of the rules laid down will enable him to make quite as perfect a piece on his bench, as he could by the above mechanical process.

PL. 10.

As stairs of six to eight inch openings, are the most in use of any other kind, there are frequently instances of many being obliged to execute them, who are but little experienced in stair-building; consequently, it is thought proper to give the most difficult parts engaged therein, in the following practical manner.

REFERENCES TO THE FIGURES.

Fig. A, Plan of the rail, front string and nosing: the outer dotted line represents the front line of the front string; (that is, the one farthest from the centre *o*, commencing at 1, and terminating at 2:) the inner dotted line represents the front line of the nosing on the platform.

Fig. B, Plan of the cylinder put up in staves, glued and screwed together.

Fig. C, The elevation and stretchout of the circular part of the front string passing over the dotted line 1 2, in Fig. A, with a part of the last step of the first flight, and part of the first of the short flight going off the platform, and landing on the floor.

Fig. D, Falling-mould for the concave side of the rail, passing over the line 5 7, in Fig. A.

Fig. E, Convex falling-mould, passing over the outer line 6 11, in the plan Fig. A.

EXPLANATIONS TO FIGURES A, B, C, D, AND E.

Fig. A, Is the plan of a rail corresponding precisely with the plan, letter A, in Plate VI, across the centre *O*, from 6 to 11; the tangent line 13 14, is the same as 13 14, in Plate VI, and is got by the same process. The dotted line 15 16, a tangent to the circular dotted line, (which is the front string,) is the stretchout of the circular part of the string; the line 17 18, is the stretchout of the concave side of the rail.

TO DRAW FIG. B, A PLAN OF THE STAIRS AND CYLINDER.

First, take the opening of the cylinder and draw it at any convenient place, say at Fig. B; then determine the location of the joint of the straight and circular part of the string,* say at *a h*; then take any number of staves, (in this design I have given only three, of which one is omitted for want of room,) and draw lines from the centre *O*, through the intersection of the two staves at *c f*, and *e d*, which will give the bevel for working the staves. For instance, take a bevel and apply the stock to the dotted line *c b*, of the stave that is connected with the straight string, and the blade, on the bevel line *c f*; then plane up the stave to fit that bevel, and so also *d c f*, and the two staves will stand precisely over the lines

* I have located this 2 and 5-8ths of an inch from the circle, which renders it easier to make the intersections of the straight and circular parts perfect, or as near so as possible.

herein represented by the letters *b c, d e, f* and *g*. To work out the circle, together with the straight part annexed thereto, first take a thin piece of board, and make its shape precisely the same as the lines *b, a, J, c, f* and *g*; then take the pattern just described, and apply it to the end of the stave, and mark round, which will produce the scribes necessary for working the stave. Proceed the same way with the centre stave, which is described by the letters *c d e* and *f*.

TO GLUE UP THE STAVES IN THE BEST WAY TO AVOID A VARIATION
BY SLIPPING OUT OF PLACE.

First, cut a place in the stave at *i*, for the reception of a screw, then take the screw *k*, and screw the two staves together, in order to make them permanent: two screws will be necessary. By thus proceeding, the cylinder may be nearly completed before glued up. The workman will also find a convenience in working the rabbit or *faciæ*, and bead; for he may work from both ways: whereas, if the whole was glued up, he would find difficulty, particularly in those small openings.

TO CUT THE JOINT, AND SCREW THE CYLINDER TO THE STRAIGHT
STRING.

First, set a guage from the line *J b* across to the line *h i*, then guage the line *h i*, then saw the line *h i* through and through down to *h*, then cut the bevel joint from *a* into *h*; then the stave being cut, the same shape will fit at *a h* and *i*; the stave is thus fitted: now drive the screws *n n*, and they being inclined as described in the plan, will bring the joint *a h* to wood and wood. As seasoned stuff is important in cylinders, I have made the staves in this example only $2\frac{1}{4}$ thick, consequently, it causes a lack of wood between *f* and *i*: To remedy that, the triangular *f i P* might be left on the straight string: it is a matter of no great consequence whether on or omitted.

NOTE.—After the *faciæ* and bead are completed, then unscrew the joints, and put on a sufficient quantity of glue; then refit them, and drive the screws as before, and the joints will be permanent and regular. The letter *q* represents the back line of the bead—*r*, the front side of the bead and *faciæ*, and *s*, the front of the upper *faciæ*.

TO DRAW THE ELEVATION AND STRETCHOUT OF FIG. C.

First, take the dotted stretchout 15 16 at the plan Fig. A, and raise them perpendicular up to 15 16 on the under edge of the nosing of the platform; then set up from 16 to 19 the height of a riser; then set down from 15 to I the height of a riser. This produces the stretchout of the cylinder, and at the same time represents a part of two common steps. The figures 3 and 4, at the extremities of the nosing, are just equal to the stretchout of the dotted line 3 4 in the plan Fig. A, representing the nosing line.

TO GET THE LENGTH OF THE STAVES.

First, find the stretchout of the staves round from *b a J c* and *d*, and apply them to the dotted lines on the under side of the falling-mould, or under side of the elevation of the front string at 1 2 3 4 5 6; then commence at 1, and raise a perpendicular line from 1 up to 1, which will be the length; the width will be from 1 to 2 on the horizontal dotted line: for the middle stave, take the perpendicular line 3 2 for the length, and the horizontal dotted line 3 4 for the width: *a a* are the joints of the cylinder to the straight string,—*b b* are the joints in the rabbit or faciæ, caused by cutting a bevel (see the joint in the plan of cylinder) at *a h*, and it will be seen at the bevel joint, by its passing from the letter *h* out to *a*, it makes the difference of the two dotted lines in crossing the projection of the rabbit of the faciæ, which is represented by the break in the two lines or joints of the cylinder marked *a b*, to the string in the elevation at the intersections of the straight and circular parts. The dotted lines 1 1 and 6 6, at the upper and lower ends, represent the line *b g* in Fig. B.

NOTE.—Before I proceed any farther, it will be proper to mention the peculiarity of a winding or circular rail passing over any number of elevated steps.

First, it is known by practical demonstration, that a hand-rail raising and winding over any number of steps, terminating in a circular cylinder, that neither two of the front and back edges will be parallel to each other; consequently it is evident that the cuts in the convex and concave falling-mould will not be parallel to each other; if both are cut square to the rake of the falling-moulds, (see Fig's. D and E placed on their envelopes) that they do not run parallel over the envelope part, but at the same time run parallel down at *s s* and up at *r r*, and is also the same distance apart at *s s* that it is at *r r*, and so also is the under side of the falling-mould to the front string, Fig. C. It will likewise be observed, that the four lines across the two falling-moulds at each end of Fig's. D and E, are square to the hypotenuse, or rake line of the pitch-boards, and parallel to each other; but the cuts at the centre of the stretchouts are not parallel when cut square to the rake or hypotenuse line. Therefore, it is a duty that devolves, through the nature of the proposals for this work, to explain satisfactorily the mysterious parts connected with the various problems or examples that are included in this work. The above references and notices are inserted for the purpose of placing in view the proper object that will be most likely to lead the student to a more direct understanding of them.

TO DRAW THE CUTS OF THE CONCAVE AND CONVEX SIDE OF THE RAIL PARALLEL, AND TO SHOW THE WOOD REQUIRED TO CUT THE JOINT IN VARIOUS POSITIONS.

First, as I have prepared this Plate to complete Plate II, it will be observed that the line 22 0 22 across the centre of Fig. E, which is the same as the letter C in Plate VI, is cut square to the

rake or hypotenuse line of the stretchout. Next it will be seen that the concave* mould Fig. D, does not run parallel to Fig. E; therefore, 23 o 23, which is square to the mould, will not be parallel to the line 22 o 22 in Fig. E; consequently, they will not make the joint required, although the moulds are both on their inclined planes: and to understand the thing perfectly, (see the two small portions of the common pitch-boards at the upper and lower ends of the two moulds, Fig's. D and E, that they are raising equal distances at the letters *s s* and *r r* at the upper and lower ends of the moulds,) now to obtain a parallel cut to the outside of the rail, draw the line 22 o 22 across Fig. D, parallel to 22 o 22, which is square to Fig. E, and the parallel cut will be complete; but at the same time will not be a square joint in front, as in the back, or convex side of the rail.

TO GET THE JOINT SQUARE IN FRONT.

First, draw the line 23 o 23 square to the concave mould D; then to make the convex side in Fig. E, parallel to it, draw 23 o 23, in E, parallel to 23 o 23, in Fig. D, and the joint will be complete—which is directly reversed to the above.

TO DIVIDE THE VARIATIONS, AND SHOW DIFFERENT QUANTITIES OF WOOD REQUIRED BY THE VARIATIONS OF THE DIFFERENT POSITIONS OF THE JOINT.

First, it is understood that the lines 22 o 22 and 23 o 23, are explained, and run parallel to each corresponding line in the two moulds; then to divide the difference, divide the distance between the two lines 22 and 23, at the ends of the lines, and in the circles running through 22, 23, into two equal parts; then draw the line o o o, through the moulds, which will produce the variation, and likewise will be square to the centre section of the rail; that is the same as to say, draw a falling-mould for the middle black line, running through the centre o, in the plan of the rail, at Fig. A, which is also the centre section of the elevation of the rail. Now to produce the wood required to cut the joint, when executed in either of the three positions represented by the lines 22 o 22, o o o, and 23 o 23, drop lines from each intersection of those lines, to the upper and under edge of the falling-mould, Fig's. D and E, down to the plan of the rail at Fig. A, and the over-wood for either will be produced at the three lines at the right and left of the line o o o o, round perpendicular through the axis of the cylinder or well-hole. The three lines each side are represented at the radiating lines 1 2 22 22 3 4, drawn from the convex side of the rail A. This, as above observed, must pass through the intersecting of the lines at the upper and under edge of the rail, or falling-moulds D and E.

* Meaning the inside of the rail in the circular part, for the same side of the rail in its straight parts might properly be termed the outside, for the well-hole is the outside of the stairs; but any diminution towards the axis or centre of a cylinder or circle, will be coming into the centre; consequently, the concave mould will be the inside mould to the circular part.

PL. 11.

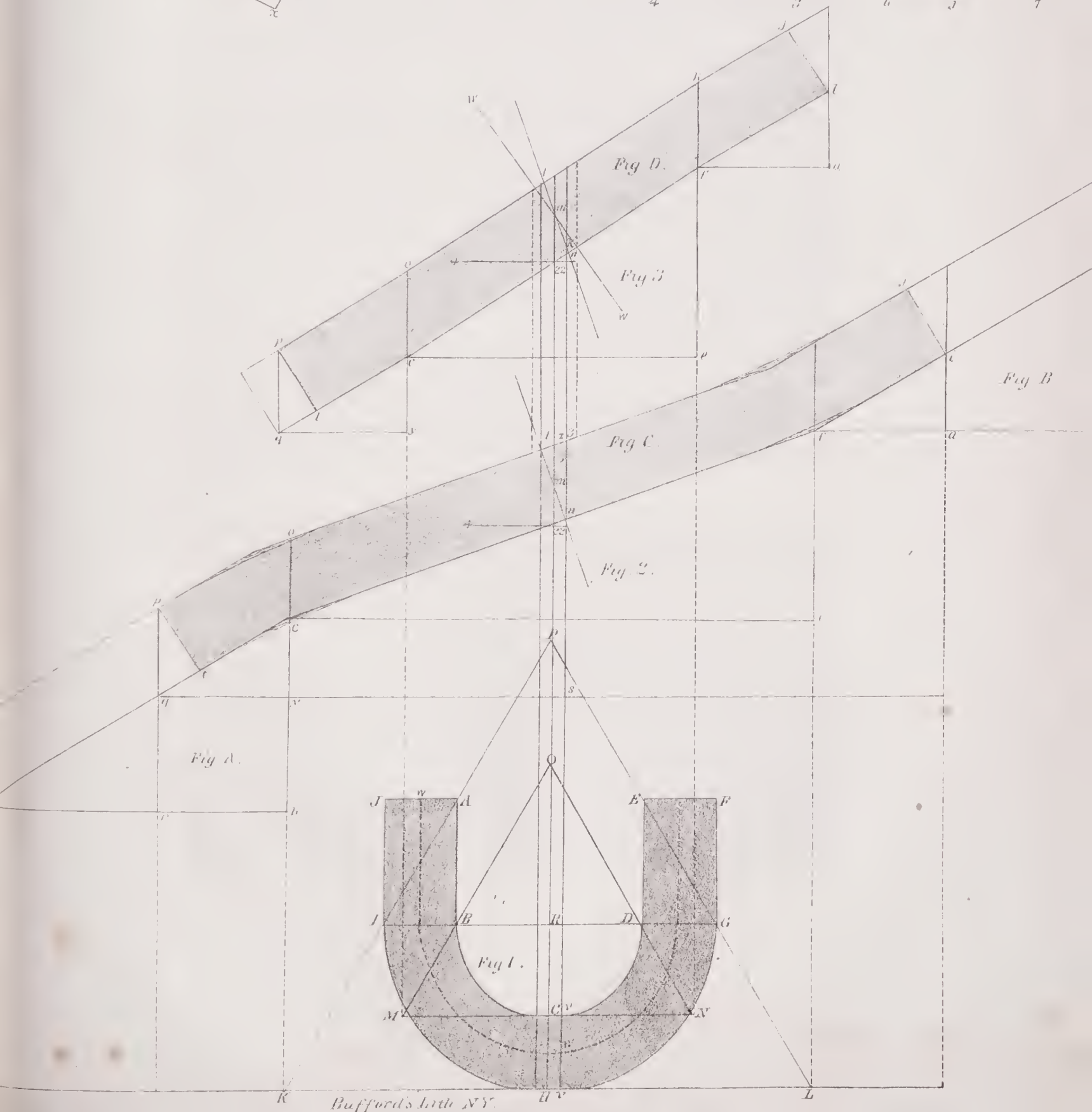
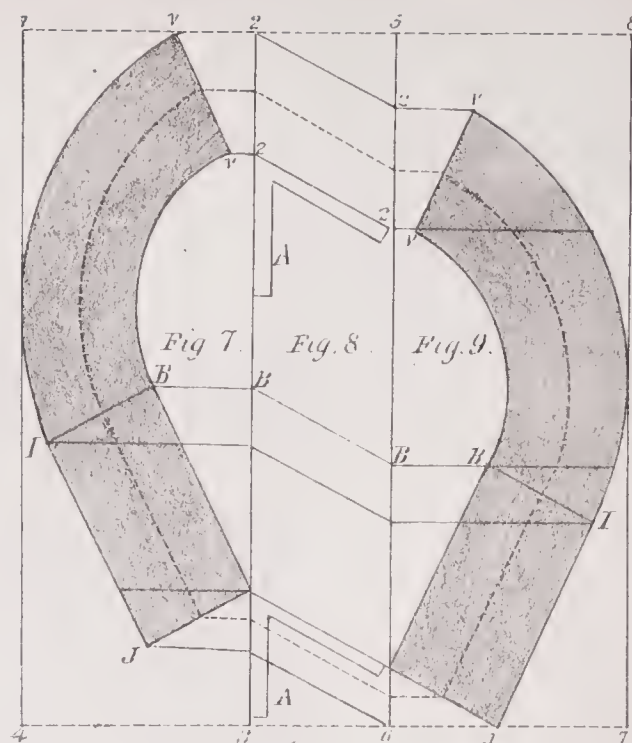
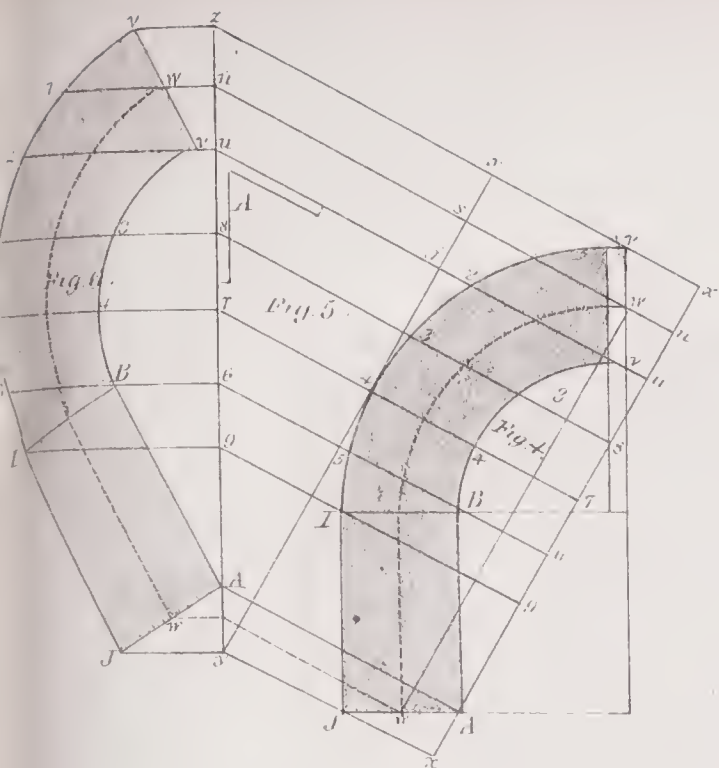
STAIR RAILING OVER A SMALL OPENING.

To furnish such drawings and explanations of the several parts of stairs as can be comprehended by workmen, not versed in science, nor much experienced in the stair department, and as will enable them to execute with a considerable degree of accuracy, it is necessary to study simplicity, both in the drawings themselves, and in the terms used for their explanation. In what follows, I shall aim to do this, even if it be at the occasional sacrifice of that verbal polish, and that scientific arrangement and explanation, which a learned reader might desire.

THE PLAN OF THE SEMI-CIRCULAR PART OF A STAIR-RAIL BEING GIVEN TO OBTAIN THE CONVEX FALLING-MOULD.

Let A C E F H J (Fig. 1) be the plan of the semi-circular part of a stair-rail, having a portion of straight rail attached to it; with the diameter, G I, of the convex side of the plan for radius, and from the points G, I, as centres, describe arcs cutting each other at P, and join P I, P G; bisect the arc I H G in H, and through H draw a tangent, K H L, of any length, and produce the lines P I, P G, till they meet the tangent: the part K L, cut off by P I and P G produced, is the extension or stretchout of the convex side, I H G, of the plan. Draw the line *c e* (Fig. 2) equal to the tangent K L, and at *e*, in the base *c e*, erect a perpendicular, *e f*, equal to the height of a step, and join *c f*; at each end of the hypotenuse *c f*, apply the pitch-board of a common step in the manner exhibited in Figs. A and B, and make *r b* or *q y* in the pitch-board *a b c*, and *f u* in the pitch-board *f g h*, each equal in length, I J or D E, of the straight part of the rail: making allowance for the easings at *c* and *f*, the line *a c f h*, formed by the hypotenuse *c f*, and the upper edges of the two pitch-boards, is the lower edge of the required convex falling-mould, of which the part *q c f i* is all that is required in this instance. On each side of the angles *c, f*, in the lower edge of said mould, set off any number of equal parts, say six or eight, and from that point of division which is nearest the angle on one side, draw a straight line to that point which is farthest from the angle on the other side; do the same from all the other points of division, and by the intersections of these lines, obtain the easings at *c* and *f*; parallel to the lower edge thus completed, and at whatever distance may be fixed upon for the width of the mould, draw a line for the upper edge, and the required convex falling-mould (Fig. C) will be completed.

The line *l m n* (Fig. C) represents a butt-joint, and C *v*, or H *v*, (Fig. 1) shews the over-wood necessary for cutting said joint, and are obtained thus: at the point H, (Fig. 1) in the tangent K L, erect a perpendicular, and produce it so as to cross the convex mould C; bisect the part, *z z*, which crosses the mould, and through the point of bisection, *m* draw *l m n*; at right angles to the hypotenuse *c f*,



and from n , let fall a perpendicular, $n v$, upon the tangent $K L$: as already stated, the line $l m n$ represents a butt-joint in the centre of the semi-circular part of the rail, and $C v$, or $H v$, (Fig. 1) is the width of overwood required to cut it ; for which overwood, allowance is made in Fig's. 4, 6, &c.

Figures 3 and D represent the stretchout and falling-mould of the concave part of the plan at Fig. 1, and are obtained in the same manner as Fig's. 2 and C ; the base $c e$ (Fig. 3) being equal to the tangent $M N$ at Fig. 1 ; $e f$, equal to the height of a riser ; $q y$ and $f u$, equal to the same portions of straight rail as in Fig's. 2 and C ; and so forth. It will be perceived, that the two falling-moulds (Fig's. C and D) have different angles of inclination ; that the line $l m n$, in order to be parallel to $l m n$ in Fig. C, (which it must be,) cannot be at right angles with the hypotenuse $c f$, as in Fig. C ; and lastly, that straight lines drawn across the mould C and D, at right angles to the base $c e$, will have unequal lengths, those crossing D being necessarily the longest. This fact must be particularly attended to by stair-builders, if they would construct hand-rails in the best possible manner. Even where attention is paid to it, some difficulty is experienced in the application of the moulds, and in the construction of the rail. Mr. Coulter, of Philadelphia, recommends the method of dividing the difference in the width of the two falling-moulds into two equal parts, and lowering the concave side of the rail a distance equal to one of these parts, at the same time that the convex side is elevated a distance equal to the other. This method, though liable to some trifling objections, is doubtless the best that has been devised. It will not, however, make an inelegant rail, if the convex side be elevated a distance equal to the whole difference in the width of the falling-moulds, without lowering the concave side at all. I will just add that, further on, will be found drawings and explanations adapted expressly to this case ; and to these the student is referred for what further aid and information he may require.

THE PLAN BEING GIVEN, TO OBTAIN THE FACE MOULD OF A STAIR RAIL, WHICH, WHEN PLACED OVER THE PLAN AT A PROPER ANGLE OF INCLINATION, WILL COINCIDE WITH THE SAID PLAN, PART WITH PART.

Let Fig. 1 be the given plan, as before, and draw $A B v v I J$, (Fig. 4) equal to that part of Fig 1 which is represented by the same letters ; join the ends of the dotted curve passing longitudinally through the centre of the semi-plan at Fig. 4, by the straight line $w w$; through the point A, and parallel to $w w$, draw a straight line, $x A x$, of any length, and parallel to it, draw another line, $y y$, of indefinite length, so as to touch the convex side of the semi-plan ; through the point J, draw a straight line at right angles to the tangent $y y$, and produce the said line through J and said tangent, till they meet in the point y ; through the middle point, w , of the end of the circular part of the semi-plan, and at right angles to the

straight line $w w$, draw the line $n s n$, of any length, and make the part $s n$ (Fig. 5) equal to $s n$ in Fig. 2; through n , (Fig. 5) draw the line $z n y$, (which line is the hypotenuse of the triangle $z y y$, and shews the rake or inclination the face mould is to have,) and through the points A, I, B , &c. in the semi-plan, and at right angles to the tangent $y y$, draw the lines $A A, 9 9$, &c. meeting the hypotenuse $z y$ in the points $A, 9$, &c.; at the points where they meet said hypotenuse, erect the perpendiculars $9 I, 6 5$, &c. (Fig. 6) making them equal to $9 I, 6 5$, &c. in Fig. 4, and the parts $6 B, 7 4$, &c. in Fig. 6, equal to the similarly named parts in Fig. 4; through the points thus obtained, trace the curves $J I v, A B v$, and you will have the face mould required.

TO APPLY THE FACE MOULD TO A PLANK FOR GETTING OUT A RAIL PIECE.

Let the oblong $1, 2, 3, 4$, (Fig 7) represent the upper side of the plank; $2, 5, 6, 3$, the thickness of the same; and $5, 8, 7, 6$, the under side. Take the face mould (Fig. 6) and apply it, as at Fig. 7, keeping the end $v v$ as far from the edge of the plank as is indicated by Fig's. 4 and 6, and tracing out its shape $A J v v$; take the pitch bevel A at Fig. 5, (which shows the angle of inclination that the rail is to have) and apply it as at A and A ; (Fig. 8) make the plumb-cuts $C C, A A$, across the edge, and also the perpendicular $c v$ on the under side of the plank, equal to $c v$ on the upper side, and then, applying the face-mould again, as at Fig. 9, complete the out line for cutting the rail-piece.

TO APPLY THE CONVEX AND CONCAVE FALLING MOULDS TO A RAIL-PIECE.

When the rail-piece has been cut out, as just described, take the convex mould Fig. C, (which is supposed to be made of pasteboard) and apply it to the convex edge of the rail-piece at Fig. 7, bending it round so that the points $p, o, 3$, in the upper edge of the mould, may coincide, each with each, with the points J, I, v , in the upper side of the convex edge of the rail-piece, and so that the lines $p q, o c, 3 n$, drawn across the mould C at right angles to its base, $c e$, may tally, each to each, with the plumb-cuts $A A, B B, C C$, made on the concave edge of the rail-piece, and continued across the under side to meet the above mentioned lines. Having applied and bent round the mould in this manner, trace lines along its upper and lower edges, and you will have the outline for finishing the convex side of the rail.

In the same way, apply the concave mould D to the concave edge of the rail-piece, making the straight part, $p o$, in the upper edge of the mould, coincide with the straight part, $A B$, in the upper concave edge of the rail-piece; and thus far, the two falling moulds will have the same angle of inclination. To find what inclination to give to the circular part of the concave mould D , from the point n , in the lower edge of the convex mould C , (which is supposed to

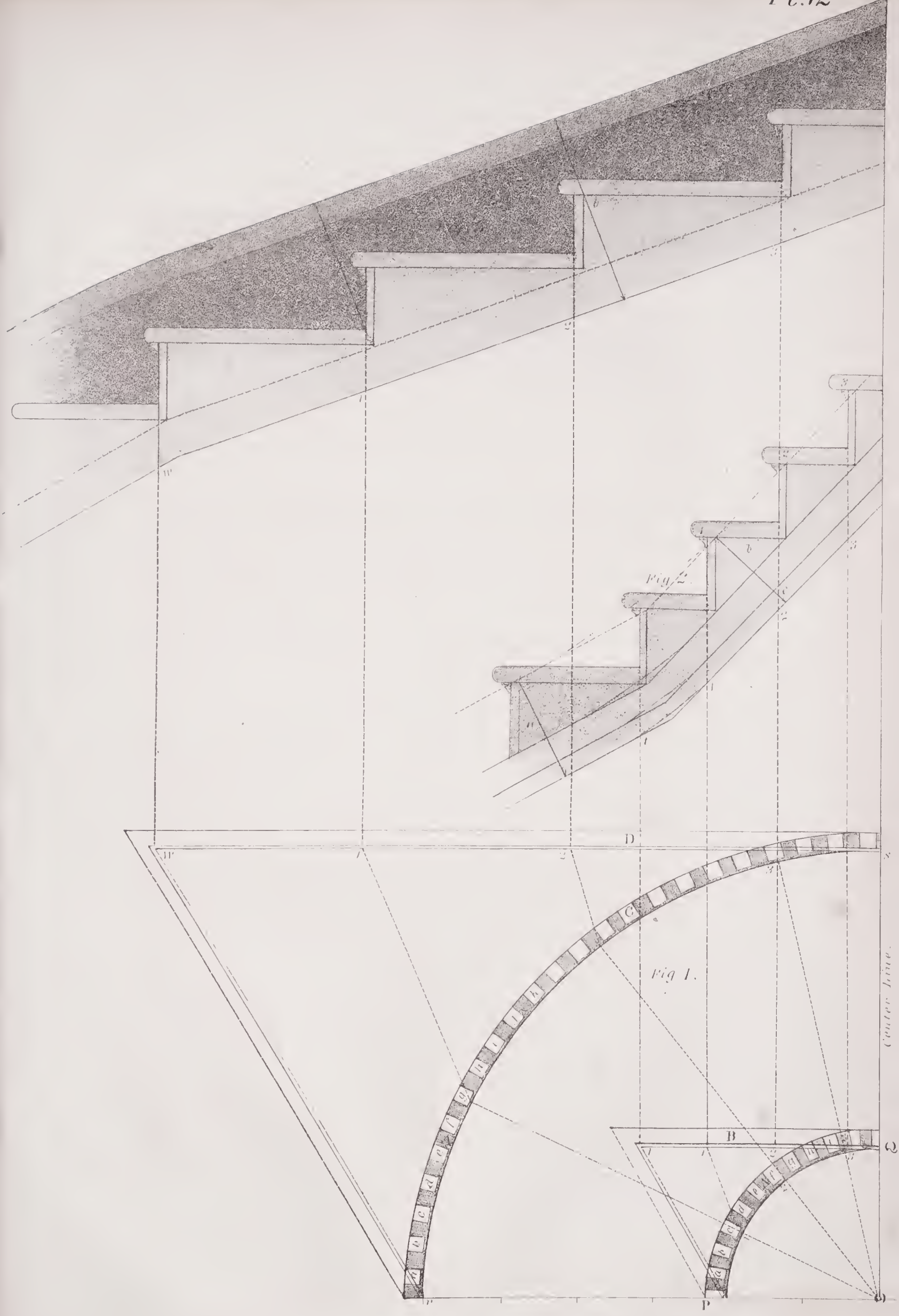
be bent round the convex edge of the rail-piece,) square across the under side of the rail-piece, and from the point 2, (Fig. D) where the line thus squared across is supposed to meet the lower concave edge of the rail piece, draw the horizontal line 2 4; from 2, in the line 2 4, set off 2 z , equal to the overwood for a butt-joint, and z will be that point in the concave edge of the rail-piece, on which the middle point in the lower edge of the circular part of the mould D, will rest. Now trace the outline for completing the concave side of the rail. Observe that the difference in the length of n 2 in Fig. C, and n 2 in Fig. D, represents the difference the two falling moulds will have in their angle of inclination.

This Plate exhibits the plans and elevations of the front and back strings of a circular stair. The arc A (Fig. 1) represents the plan of the front string, or string adjacent to the opening, and C, the plan of the string contiguous to the wall. B and D are the stretchouts of said arcs, and the several divisions in them correspond, in location, with the several divisions made in A and C by the dotted radii, which, from the centre O, pass through the front of each step to the plan of the back string. In the plans A and C, *a, b, c, &c.* represent the wedges supposed to be inserted on the convex side of the two stair-strings, and made to penetrate to a greater or less depth, and to be a greater or less distance apart, according to the greater or less extent of the circles in which the strings are spirally to wind. In this example, the wedges in the front string are made to reach to within about an eighth of an inch (see the scale at bottom) of the concave side, and to be about seven-eighths of an inch apart; while those in the back string only come within about a quarter of an inch of the concave side, and are about an inch and a quarter apart. The wedges may be shorter and further apart in the back string than in the other, for the reason that the back string winds in a larger circle than the front one, and of course has a less prominent curvature. The depth to which the wedges penetrate, and their distance apart, must be left to the discretion of the workman. Care must be taken that they be not too far apart, for if they are, the concave sides of the stair-strings will present a succession of plane surfaces and angles, instead of that regular curvature which they are intended to exhibit.

Fig's. 2 and 3 represent the elevations of the front and back strings, and are obtained by a process so very similar to that by which the falling moulds in the preceding plates are found, that no explanation will be necessary.

In Fig. 2, *c* represents a separate piece, intended for insertion, at its upper edge, into a groove to be made in the under edge of the front string, after it has bent to its true shape, and has become entirely dry. In the same way a separate piece may be inserted into a groove in the upper edge of the back string at Fig. 3. The line *a* (Fig. 3) shews the width of the skirting when got out separately, and the line *b* is the width of the back string and skirting, when they are got out in one piece. When got out in one piece, channels or mortises are made in it, for admitting the ends of the treads and risers. Whether the strings be mortised for inserting the ends of the steps, or whether it be notched, a pitch-board must be applied to it, and lines traced for the treads and risers; but the places for the ends of the steps must not be cut out until the string is bent, wedged and dried.

To give the strings of a circular stair their proper curvature and spiral twist, make, for each string, a cylindrical block, that is, make two frames with battens, or narrow strips of board, nailed on longitudinally, and rounded off at the outer edges, so that each frame



Buffers with N.Y.

Center Line.



shall, following the outline of the battens, be cylindrical, and have the respective curvatures of the circular wall and well-hole. Around these cylindrical frames bend your stair-strings, gluing in the wedges as you proceed, and, if you please, gluing a piece of coarse canvass over the wedges.

NOTE.—In making the apertures for the wedges on the convex side of the strings at Fig's 2 and 3, care must be taken to cut them at right angles to the stretchout D, (or any other horizontal line,) instead of cutting them at right angles to the edges of the elevations.

HAND RAILING. Hand-railing is the art of forming hand-rails by moulds according to geometrical rules. The principles upon which this art depends, are that of cutting a right prism through any three given points in space, and that of forming a development of any portion of the surface of the prism.

In order to illustrate this, let the interior surface of the surrounding wall be that of an entire cylinder, and let the breadth of the steps be divided into the frustrums of equal and similar sectors, and let the heights be all equal, as is universally the case; then, if an interior cylindric surface be erected concentric with the wall and the ends of the steps or surfaces on which we tread, and the planes of the risers tending to the axis be supposed to meet the interior cylindric surface, it is evident that if the portion of the intercepted surface contained between the indented line formed by the ends of the steps, and the circumferent line at the base, be developed or stretched out, all the points of the indented line formed by the outward or salient angles, will be in the same straight line, and all the points formed by the inward or re-entrant angles, will be in another straight line. It is also evident, that this will not only be the case with cylinders, but with cylindroids, and every other description of prism; that is, the points of the development of the indented line will always have such a position, that two straight lines parallel to each other may be drawn through the whole number of points.

The points of concurrence of the salient angles are called the nosings of the steps.

The line drawn through all the nosings of the steps, is called the line of the nosings.

Now let the portion of the cylinder before uncovered, be again enveloped, the development in this case becomes an envelope, and the line of nosings becomes an uniform helix, which would be the form of the rail for such a stair.

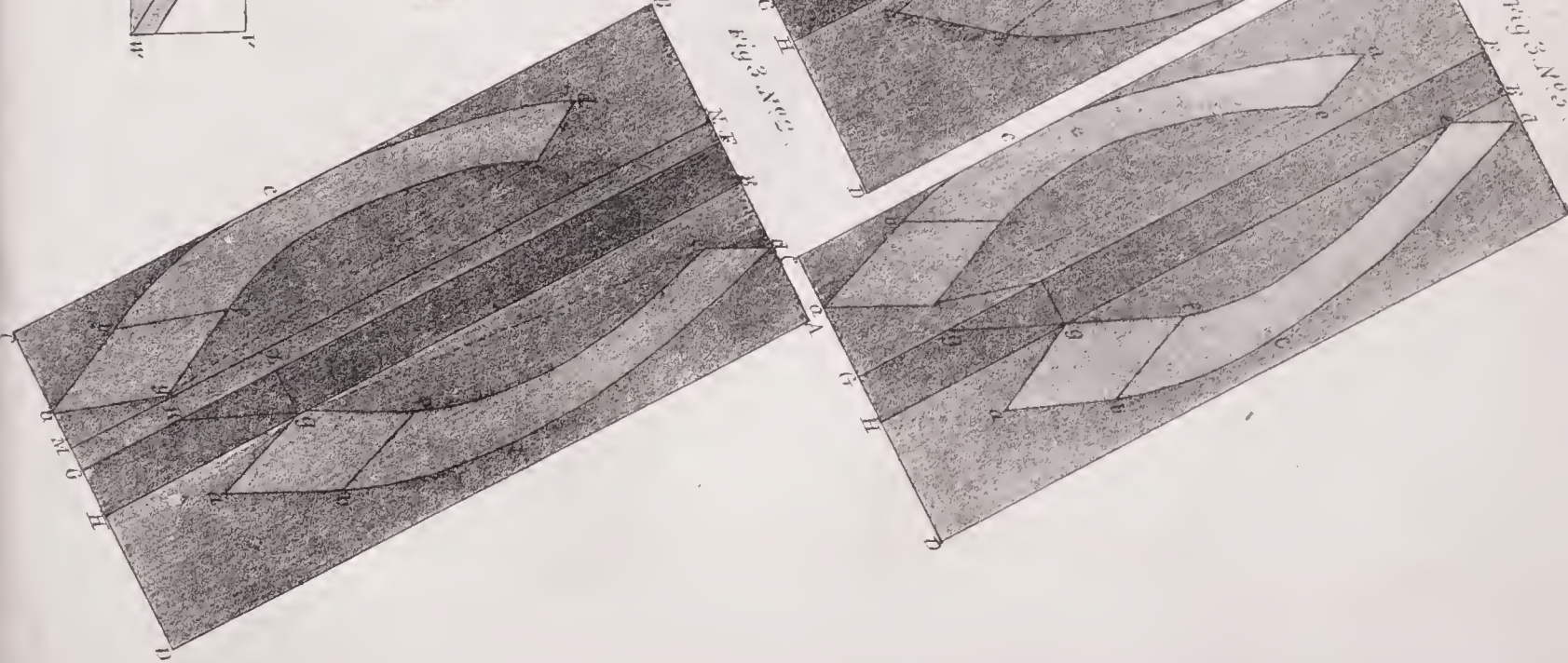
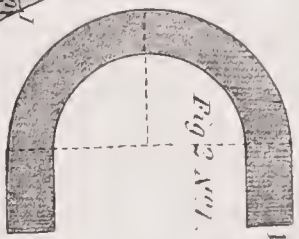
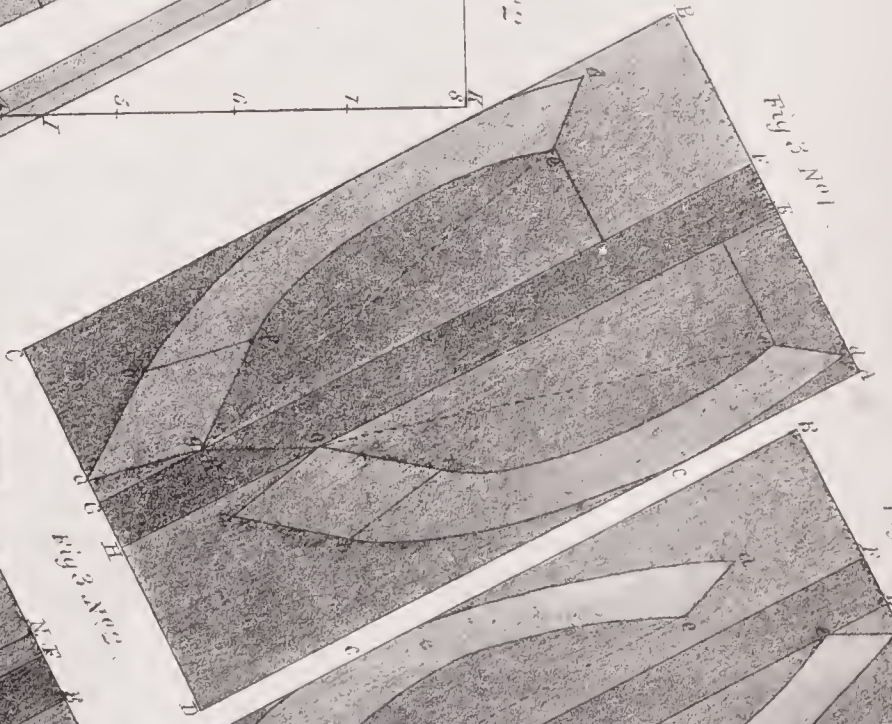
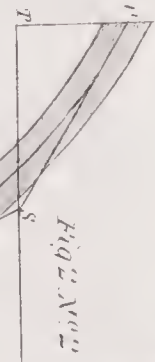
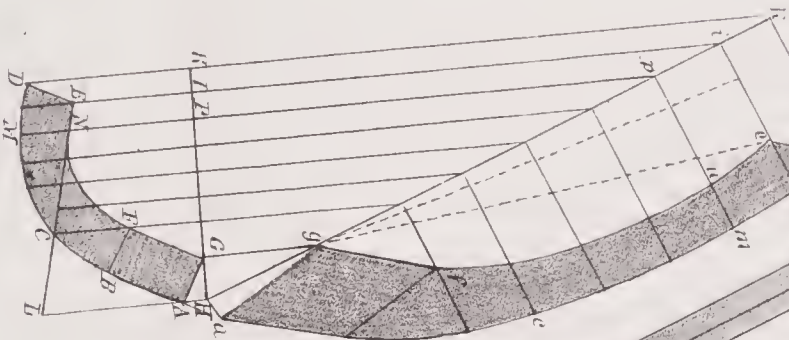
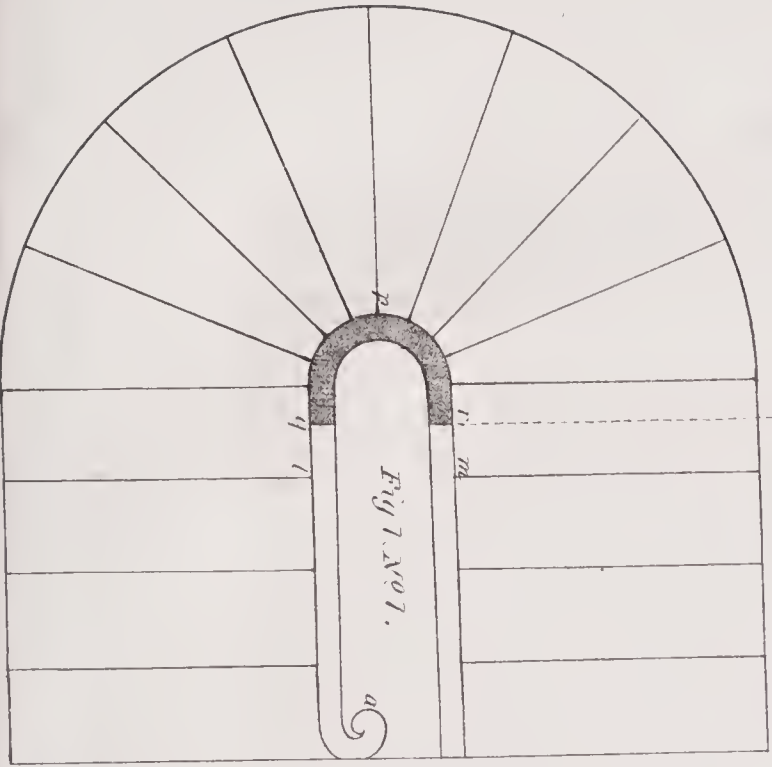
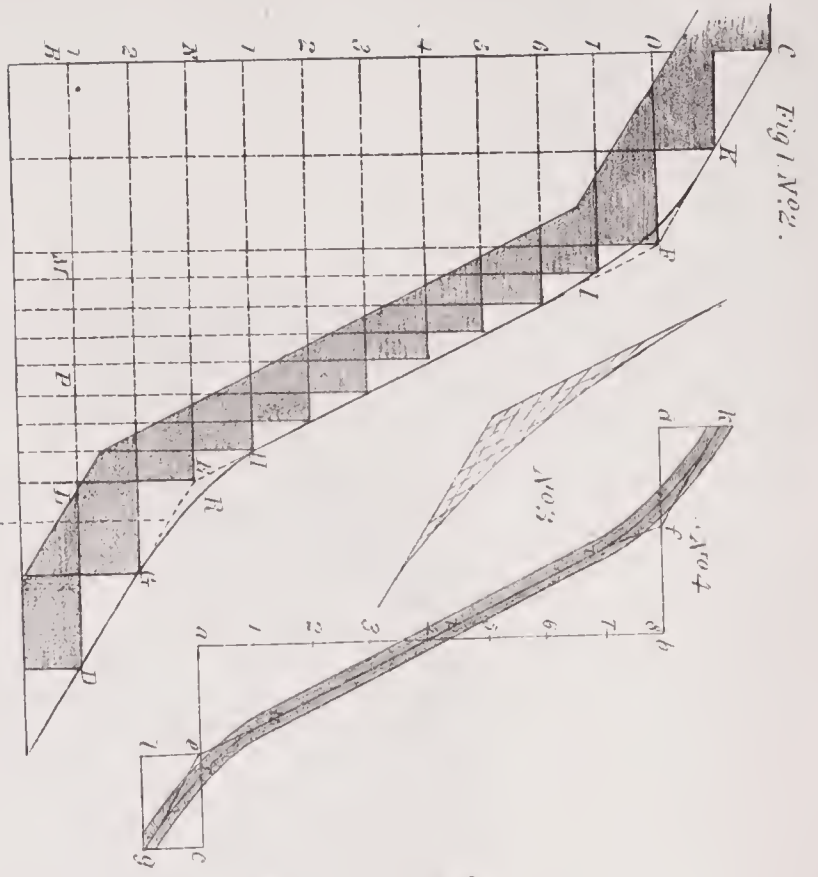
In this case it would be easy to execute the rail to any length we please, in equal portions succeeding each other; for as the curvature of the helical line is every where the same, the same moulds which are used in the formation of one piece, would serve for every succeeding piece.

The steps placed around the circular part are termed winders; in these the risers tend to the axis of the cylinder.

Steps which have their treads the same breadth, are termed flyers; in these the risers are all parallel.

Very few staircases are however entirely circular, but those of the semi-circular form, with winders in the semi-circle, and flyers below and above, are very numerous; in such the line of nosings would be crooked, and would form an angle at the junction of the flyers and the winders, and that round the semi-circle would be a helix, consisting of half a revolution.

In the development of the steps, the line of nosings would con-



sist of three straight lines, the two straight lines through the nosings of the flyers would be parallel to each other, and each extremity of the middle one would join one extremity of each of the other two ; the angles are commonly taken away by introducing a curve in their places.

A hand-rail, however, is not a mere helical line, but a solid, which may be contained between two concentric cyllindric surfaces, or concentric prismatic surfaces. The principles are the same, whatever be the form of the plan. A solid erected upon any plan, is called a prism ; a cylinder is therefore a round prism, and a cyllindroid an elliptic prism. A hand-rail may stand upon a circular base, or partly circular and partly straight, or upon an entire elliptic base. In the construction of hand-rails, all prisms are excluded which consist of plain surfaces, or, which is the same thing, where the sides of the plan consist entirely of straight lines, as in such cases, the rails themselves are either straight, or partly curved and partly straight from the top and lower sides only, the sides being in vertical planes.

We shall therefore confine ourselves to prisms that stand upon a circular base, or upon an elliptic base, or upon a base that is partly circular and partly straight, or, lastly, upon a base that is partly elliptical and partly straight. These two last may be said to have compounded bases or plans, and the former two simple bases or plans ; let us call such a prism a curved prism.

The plan of any curved prism is understood to be of the same breadth, and consequently the solid erected thereon will be every where of the same thickness. The prism may therefore be a hollow cylinder, or a hollow cyllindroid, or a concave body partly cyllindric and partly straight ; the latter may be open on one side, and may have the four planes which join the curved surfaces parallel to each other, and tangent to each of the cyllindric surfaces.

Let us therefore suppose such a prism as that last mentioned, and let us suppose it to be cut entirely through its vertical surfaces, in such a manner that any point in the surface of division may coincide with a straight line every where perpendicular to the external prismatic surface, then, every such line will be parallel to the plane of its base, and those lines in the cylindrical part of the prism will tend to the axis. Now it is evident, that the cut or dividing surface will not be a plane, but will wind or twist between the cyllindric surfaces. It is also evident, that the cut may pass through a line drawn in any manner we please, in one of the prismatic surfaces ; or, that the development of this line may have any degree of curvature in the whole length, or in any portion of the length, or may even be a straight line. One of those being supposed to be the case, let the upper part of the prism be taken away, then the upper surface of its remaining part will be brought to view ; let a line be drawn on the exterior surface, parallel to the arris, and another on the concave side, parallel to its arris ; and let another cut or dividing surface be made to pass through the two lines thus drawn, and let the upper part be removed by this division, then the part thus removed

will form a solid helix or kind of half screw, which may be either uniform in its upper and lower surfaces, or have any degree of curvature in any part that may be required, according to the development before mentioned. This is the form of the rail for such a stair, but to form the solid helix, without cutting it, from a hollow curved prism, is the thing required to be done in hand-railing.

Now, seeing that two of its sides are actually cylindrical, and would be vertical if placed in position; and that the other two winding surfaces may be formed to any development we please; let us therefore take any determinate portion of the helical solid, as a quarter of a revolution, or perhaps something more, as occasion may require, and endeavour to form such a portion or wreath out of a thin plank, instead of cutting it from a solid curved prism. Before this can be done, it is necessary to understand the principle of cutting a prism through any three fixed points in space, by a plane passing through these points; the points may be in the surface of the prism itself, and may be either all in the concave side, or all in the convex side; or partly in the concave side, and partly in the convex side:—That such a supposition is possible will readily appear, since any three points are always in the same plane; and, therefore, the plane may cut the prism through any three given points.

The three points through which the section is cut, are said to be given, when the seats are given on the plane of the base of the prism, which plane is understood to be at right angles to the axis of the prism, and when the distance or heights from the seats to the points themselves are given.

It is always to be understood, that the three seats are not in a straight line, and consequently the three points themselves not in a straight line.

The seat of a point in space on any plane, is that point in the plane, where a perpendicular drawn through the point in space, cuts the plane.

This being established, we shall proceed to shew the best means of applying these principles to hand-railing.

In the helical solid, the winding surface connecting the two prismatic surfaces, was defined to be of such a property, as to coincide with a straight line perpendicular to the exterior prismatic surface. and consequently, if the axis of the curved prism be perpendicular to the horizon, every such line will be parallel to the base; now, let the seats of three such lines be given on the plan, *viz.* let each extreme boundary be one, and let another be taken in the convex side, passing through the point which would give the middle of the development of the said side of the plan; the three seats would be terminated by the convex and concave sides of the plan, and will always be perpendicular to the convex side, and equal in length to each other. Let us call the three level lines, of which their seats are given, the lines of support; let a plane be laid on the three lines of support, the plane will either rest upon three points or upon one of the said lines and two points; it is evident

that the points which come in contact with the plane, will be at one extremity of each line of support ; let each of these points which come in contact with the plane thus posited, be called a resting point. The three resting points are the three points in space, through which the plane is supposed to pass, that cuts the curved prism.

Now, because, that each line of support has two extremities, there will be six extreme points in all, but as only three can be resting points, unless the plane coincides with one of the lines of support, it will be proper to shew, which three of the six are the resting points. Let the plane, thus laid upon some three extremities of the lines of support, be continued to intersect the base of the curved prism, then the nearest extremity of the seat of any line of support to the intersecting line, is the seat of the resting point of that line.

For this purpose let a development of the convex side of the rail be made according to the plan and rise of the steps. The part of this development that is made to bend round the convex or concave cylindric surface of the helical portion or wreath, is called a falling mould, which is supposed to be brought to an equal breadth throughout its length. Only one falling mould is used in the construction of hand-rails. Let, therefore, the falling mould for the convex side be constructed, and let two straight lines be drawn from the ends of the upper edge of that part of the falling mould corresponding to the ends of the wreath, perpendicular to the base of the whole development ; also, let another intermediate line be drawn parallel to the other two, so as to bisect the part of the base intercepted by the said two parallels : the three parallels will thus give the heights of the three resting points, the shortest height is at one extreme, and the longest at the other. Suppose now, the shortest of these three heights taken from each of the three, and the remainders taken at heights, instead of the whole, then the height of the first resting point will be nothing, and will therefore coincide with its seat ; then, if the middle height be less than half the length of the remaining height, the seats of the resting points will be the first and second extremities of the first and second lines of support taken on the convex side, and the extremity of the third on the concave side. The first resting point is a point in the intersection of the plane of the base with the inclined plane.

The process is now completely reduced to that of finding the section of a prism through three given points, which suppose to be done, and the plane of section will touch the supposed wreath, at the resting points of each line of support, without cutting the wreath of any such line—then, the three lines of support will be on the same side of the plane, *viz.* on the under side. Let us suppose now, another section taken below, and parallel to the former, so that the wreath may be just contained between these parallel sections, or planes ; the distance between the two sections will represent the thickness of the plank.

The section of the prism through its vertical surfaces, is called

the rake, or the rake of the plan : and a mould being cut to the rake, is called the face mould.

The above are the general principles ; the particulars will be best understood by the explanations which accompany the diagrams in the Plate, and the following engravings.

Let fig. 1, No. 1, in the Plate, be the plan of a geometrical stair, with eight winders in the semi-circle, and flyers above and below ; the first or lower steps being denoted by the scroll *a* ; let *q l p m r* be the plan of the part of the rail that is to be formed in two wreaths ; and *q l* and *m r* straight parts ; in order for the better securing of the wreaths to the straight parts opposite the flyers.

Let fig. 1, No. 2, be the development of twelve steps, including that of eight winders, two flyers below and two above ; *D B* being the base, and *B C* the height. In the base *D B*, No. 2, *L P M* is the development of *l p m*, No. 1, and *L D*, *M B*, the breadths of two steps corresponding to the plan. In the height *B C*, *N O* is the height of the winders, and *N B*, *O C*, each the height of two steps answering to the flyers at each end. *D E F C*, is the line of nosings ; the parts *D E*, *F C*, of the flyers, being parallel to each other, and joined by the part *E F*, the development of the winders ; *G R H*, and *I S K* are curves tanged by the straight lines *E D*, *E F*, and *F E*, *F C*, at the points *G*, *H*, *I*, *K*, or rounded off, as shewn at No. 3, on, a longer scale, so as to form an agreeable curved line without angles.

The line *G R H I S K* may be called the line of the rail, being of the same form as the line bisecting the breadth of the development of the rail, for the one may be supposed to be every where of the same height from that of the other, and therefore, the line *G R H I S K*, may be conceived to be the development of the rail.

No. 3 shews the manner of drawing the tanged curves *G R H*, and *I S K* ; No. 2 the upper one *I S K*, being the same as the lower one *G R H*, but inverted.

No. 2 shews more lines than are wanted in practice, in order to shew the connexion between the development of the steps, and the development of the line of the rail. But, as the development of the line of the rail is all that is wanted, make *a b*, No. 4, equal to the height of the winders, draw *a c* and *d b*, at right angles each with *a b* ; make *a c* and *b f* each equal to the development of *l p* or *p m*, No. 1 ; make *e c*, and *f d*, the breadth of a step ; draw *c g* and *d k* parallel to *a b* ; make *c g* and *d k* each equal to the height of a step ; join *e g f k* and *e f* ; make *e h* equal to *e g*, and *f i* equal to *f k*, and draw the tanged curves *g r h* and *i s k* as before ; then *g r h i s k*, will be the line of the rail, as in No. 2 ; for *e f* will be obtained, equal to *EF*, No. 2 ; and *e l g* will be the section of a flyer at the lower end, and *f d k* the section of a flyer at the upper end. The breadth of the falling mould, in common cases, is about two inches, therefore, two lines being drawn parallel to the line of the rail, each at an inch distance from it, gives the complete falling mould for both wreaths. The two parts of the falling mould, as

divided by $a b$, are equal and similar to each other, and would therefore coincide if applied together.

Let fig. 2, No. 1, be an enlarged plan of the rail, of double dimensions to No. 1, fig. 1, in order that the moulds may be more exactly obtained, and the construction more clearly seen. Let $A B C D E F G$, fig. 2, No. 3, be the plan of the part of the wreath to be formed, $A G$ being the seat of the line of support at the lowest part, and $D E$ that at the highest part: then A is the seat of the resting point of the lowest end, and E that at the highest end. Take the point C , between A and D , so that C , in the development of the line $A B C D$, may divide the said development in two equal parts.

Let $A B C D$, fig. 2, No. 2, be the development of the curve $A B C D$, No. 3; the parts $A B$, $B C$, $C D$, being the respective developments of $A B$, $B C$, $C D$, No. 3. In No. 2, draw $D K$ perpendicular to $D B$; and make $D K$ equal to the height of eight steps; draw $K S$ parallel and equal to $D B$; join $B S$; produce $K S$ to T , and $D B$ to V ; make $S T$ and $B V$ each equal to the breadth of a step; draw $T U$ and $V W$ parallel to $D K$; make $T U$ and $V W$ equal to the height of a step; join $W B$, $B S$, $S U$: then $W B S U$ is the line of nosings. The whole is completed as in No. 3, fig. 1. Draw $A X$ parallel to $K D$, cutting the upper side of the falling mould at X ; draw $X Z$ parallel to $A D$; produce $K D$ to Z , and let $K D$ cut the top of the rail at I ; through C draw $Y J$, parallel to $D K$, cutting the top of the rail at J , and $X Z$ at Y ; then $Y J$ and $Z I$, respectively, are the height of the resting points, whose seats are C and E No. 3. In No. 2, draw $J R$ parallel to $B D$, cutting $D K$ at R . In No. 3, join the seats E and C of the resting points and produce $E C$ to L . In $J R$, No. 2, find the point O , by making $R O$ equal to $E C$, No. 3; join $I O$, and produce $I O$ to meet $X Z$ at Q . In No. 3, make $E L$ equal to $Z Q$, No. 2, and join $A L$; through G draw $H K$, perpendicular to $A L$, and produce $L A$ to H ; through E draw $E i$ parallel to $L H$, cutting $H K$ at i ; make $I i$ equal to $Z I$, No. 2, and join $H i$, and produce $H i$ to k . To find any point in the curve of the section, take any point M in the boundary of the plan, and draw $M p$ parallel to $E i$, cutting $H i$ at p and $H I$ at P ; draw $p m$ at right angles to $H i$ and make $p m$ equal to $P M$, and m is a point in the boundary of the rake. In like manner, let $M P$ cut the concave side of the plan at N ; in $p m$ take $p n$ equal to $P N$, and n is a point in the concave side. A sufficient number of points being thus found, draw a mixed line, $a b c d e f g$, through the whole and $a b c d e f g$, is the figure of the rake. For greater accuracy and despatch, it will be necessary to find a point in the rake corresponding to the extremity of every straight line in the plan, as shewn by small letters of the same names as the capitals on the plan. The part $A B F G$ being a parallelogram on the plan; the corresponding part $a f b g$, on the section, is also a parallelogram; in this case it will be only necessary to find the points a , g , f . Join $a g$ and $g f$; draw $a b$ parallel to $g f$, and $f b$ parallel to $g a$, and the point b gives the commencement of the convex curve $b c d$ and the point

f that of the concave curve. It remains to be shewn that H L, No. 3, is the intersection of the plane on which the section of the prism is formed; for the point A is not only the seat of the lowest resting point, but the resting point itself. A is therefore the point in the intersection of the cutting plane. In No. 2, draw O Δ parallel to K Z cutting B Z at Δ ; conceive the triangle I Q Z to be removed to No. 3, so that the point Z may be upon E; and because R O Δ Z is a parallelogram, Δ Z is equal to R O, and R O is equal to E C by construction; therefore the point Δ will fall upon C: and by construction the point Q will fall upon I. Conceive the triangle, with its base, thus coincident with L. E, to be raised perpendicularly to the plan; I will be the resting point over E and O the resting point over C; therefore the points I and E will be in the plane of section, and consequently be the straight line I O Q; but the point Q, now supposed to be coincident with L, is common to the plane of the base; and the plane of section Q, is therefore a point in the intersection of the cutting plane and the base. The point A has likewise been shewn to be a point in the intersection; therefore the straight line H L, passing through the points A and L, is the intersection of the cutting plane, with the plane of the base. The point L, No. 3, will be obtained also by a fourth proportional to I R, I Z, R O, or Z Δ No. 1, setting it from E. to L.

A mould being cut to the form of the section, as here obtained, is called by workmen, the *face mould*, which we shall suppose now to be made.

To find the Thickness of the Plank, out of which the Wreath is to be cut.—Let Z I, No. 2, cut the under edge of the falling mould at ϵ , transfer Z ϵ upon K k , No. 3, from K to δ : then the nearest distance between the point δ and the straight line H k , is the thickness of the stuff at the upper joint.

The wreath, when formed into two prismatic surfaces, and into two winding surfaces, is said to be squared. This formation is all that is required from geometrical principles. Then, supposing the wreath set in its proper position, every section made by a vertical plane, perpendicular to the convex side of the plan, will be a quadrilateral with its two vertical sides parallel, and at right angles to the upper side, and at oblique angles to the lower side. This arises from the top being so formed as to coincide in every part with the line perpendicular to the prismatic surface as defined, and the lower winding surface by guaging upon each cylindrical surface from the top.

To draw the Rake on the Slides of the Plank, in order to plumb the two sides of the Wreath.—Let A B C D, fig. 3, No. 1, be a development of three sides of plank; let A E, H D, be the top; E F, G H, the edge; in breadth equal to the thickness of the stuff obtained from No. 3, and F B, C G, the under sides; let the lines E H and F G be parallel to k H, fig. 2, No. 3, in order to be more easily comprehended, (as otherwise, it is not necessary;) let $a b c d e f$, on the top of the plank, be the rake formed by the face-mould, the point g being in the line H E, and the line $g e$, making the same

angle with $g E$ as the line $g e$, fig. 2, No. 3, makes with $g k$, draw $g K$, making the angle $H g K$ equal to the angle $H k K$, or $H i l$, or $H p P$, fig. 2, No. 3, cutting the arris, fig. 3, No. 1, $G F$, at K , then the same mould being drawn on the under side, with the point g at K , and the chord $e g$ making the same angle with $K F$, that $e g$, on the upper side, makes with $g E$, or the distance of the point e from $G F$, on the lower side, equal to the distance of the point e from $H E$, on the upper side. Let us now suppose lines drawn in the above manner upon the three corresponding surfaces of the plank to that of the figure, and let the plank be cut out with a bow saw. In the act of cutting, the kerf must be kept close to the corresponding lines of each rake, and the line of the teeth of the saw parallel to $g K$, and when the piece of the wreath is entirely divested of the superfluous wood, the sides thus formed will be plumbed.

To draw the Rake upon the Plank in every Position to the adjoining arris of the Edge.—Let fig. 3, No. 2, be a development of the plank as before, the same letters referring to the same parts. Let $a b c d e f g$ be the rake drawn by the face-mould, the point g being in the arris $H E$, and the chord $g e$ forming any given angle with the arris $H E$, less than that formed in No. 1, fig. 3, by the chord $g e$, and the arris $H E$; find g as before from No. 3. In No. 3, draw $g I$, making the same angle with the pitch line $g k$, as $g e$ makes with $g E$, in fig. 3, No. 2, draw $g L$ perpendicular to $H E$, cutting the lower arris $G F$ in L ; make the angle $K L g$ equal to the angle $e g I$, fig. 2, No. 3; make $L g$ equal to $L K$; through g draw $M N$, parallel to $G F$; then drawing the rake upon the lower side by the edge of the mould, so that the angle $e g N$, on the said lower side, may be equal to the corresponding angle $e g E$, on the upper side; the two sides of the piece that is to form the wreath may be plumbed as before, so as to correspond with the plan when set to its position.

If it is required to draw the rake with each extremity of the concave side of the mould in the arris of the plank as in fig. 3, No. 3, it is only making the angle $K L g$ equal to the angle $e g k$, fig. 2, No. 3; the rest is drawn, and the plumb side is formed in the same manner as No. 1 and No. 2, fig. 3, which suppose to be done, bend the corresponding part of the falling mould, fig. 2, No. 2, round the convex side of the piece for the wreath; bring the points X and J to the plane at the top, and draw the line of support at the upper extremity upon the end of the wreath; now, bring the upper end of the falling mould close to the extremity of the line of support, and draw a line by the upper edge of the falling mould; cut away the superfluous wood in the manner before described, and this will form the back or top of the rail; then gauge the two vertical surfaces to the same breadth, and cut the superfluous wood away from the under side; this portion of the rail will then be squared. The wreath for the other portion above, is identically of the same form; therefore, if two pieces are prepared by the same moulds and levels, then supposing one of these wreathed pieces to be set in its position for the lower part, and let the upper part be set in the same position,

and then inverted, so that the top and bottom ends, and the upper and lower winding surfaces, will have changed places, but each of the vertical surfaces kept still upon the same side ; let the lower end of the higher piece be brought to contact with the higher end of the lower piece, that the two planes may coincide and form a joint ; the helical solid for half a revolution will be formed out of a straight plank, as required to be done.

The two wreathed portions of a hand-rail are not always alike, as in the preceding example ; this may happen in different ways, as from one quarter of the semi-circular part being divided into winders, and the other undivided, or, from the rail being placed higher upon the winders than over the flyers ; but in whatever way the variation takes place, the application of the principle is the same ; it only requires moulds to be constructed for every such variation, or separate part.

The intricacy of the diagrams constructed upon the inventor's former principles, prevented their being generally understood, and very few could practice with success. But the principles here laid down, are so invariable in their result, so simple and expeditious in their application, and so easily to be comprehended, even by a moderate capacity, that they cannot fail of being introduced into general use. They unite the requisite properties of saving labor and stuff, the workman constructs his moulds with ease, and has less superfluous wood to remove. The edge of the plank is kept square, which entirely supersedes the bevelling, and is even in this point attended with a considerable saving of stuff and time, as it allows sufficient wood at the ends to make the heading joints, and as the piece which is cut out of the rail piece from the hollow side, may be turned into use ; but if the edge of the plank were bevelled, it would require to be much longer, in order to form the heading joints, and the piece cut out would be too trifling to be employed to any purpose.

In addition to the advantages already enumerated, the workman will be encouraged by the clearness of the different steps of the process, which cannot fail of fully satisfying his mind as to the final result.

It is likewise a great accommodation, that any rail whatever may be cut out of the same thickness of plank, and that the mould may be applied in any direction which the workman pleases to the surface, in order to save wood or match the fibres at the joint.

The art of forming hand-rails round circular or elliptic well-holes, without the use of a cylinder, is entirely new.

Price, the author of the "*British Carpenter*," is the first person who seems to have had any idea of this art ; the subsequent writers following his schemes, which were very uncertain in their application, have added nothing to the subject, but have even thrown it into greater obscurity.

The first successful method of squaring the wreath or twist, was invented and published in the "*Carpenter's Guide*," in 1792 ; and certainly was the first wherein the process was subjected to any thing like geometrical principles, from which the result was attended

with success. In the "*Carpenter's Guide*," (generally called simply "*The Guide*,") the formation of the face-mould was regulated by the falling mould or the development of the rail, not by the rise and tread of the steps, as shewn by Price and his followers. When the back or upper surface of the rail had a considerable concavity, as in the case of junction of flyers and winders, the consequence of this regulation in many cases, in the formation of the rail, was the saving of seven or eight inches in the thickness of stuff; and thus, while the method laid down by Price required a plank from six to nine or ten inches in thickness, according to the degree of concavity; that in "*the Guide*" seldom required a plank more than three inches thick, excepting in small well-holes of three or four inches in diameter.

From the great thickness of stuff to cut through, and the quantity to be taken away, the time required to form the piece of wood into a wreath by Price's method, must have been at least double to that in "*the Guide*," and proportionally more so, as the thickness of the plank required by Price, was greater than that in "*the Guide*."

But though considerable advantages were thus obtained in the saving of stuff and labour, it must be observed, that an elevation of the supposed vertical ends of the twisted piece at each joint, and a vertical section of the said piece, were employed to obtain the inclination of the plane of the face of the mould, or that of the faces of the plank; this inclination was only correct when the planes of the faces of the plank were at right angles with the chord plane, or that passing through the chord of the plan of the wreath; but when inclined to the chord plane, required thicker stuff, in proportion to the degree of obliquity, whether more acute or more obtuse.

The method shewn in "*the Guide*," was also the first attempt to spring the plank, that is, to make its plane rest upon three parts of the rail; and though the utmost degree of perfection was not attained, it has been of great use to workmen, as all the hand-rails of stairs in and about London, and in most parts of England, have been executed upon its principles for upwards of thirty years.

To obtain still greater correctness, the inventor tried another method, by setting up three heights, supposed to be on the surface of a curved prism, in the middle of the rail; but this, though still nearer than that published in "*the Guide*," did not give him entire satisfaction; for the resting points being in the middle of the rail, the plane of section which formed the face-mould did not clear all the three sections without cutting into the solid of the wreath.

In the pursuit of truth, he was led to consider what would be the real resting points. It readily appeared, that a level line drawn towards the axis of the well-hole, might be made to coincide in every part with the top of the rail; that if the plane of the top of the plank be supposed to be placed on three vertical sections of the supposed rail in contact with a point in each, or coincident with the whole line of support of one of the sections, and with a point in each of the other two; and the surface of the plank thus inclined be supposed to be prolonged, to intersect the horizontal plane of the base, the

intersection would always point out the resting points, and shew their true seats upon the plan. From this consideration, it was evident that the resting point of each section, and consequently each seat, was that extremity of each section next to the intersecting line of the plane of the plank and that of the plan.

This theory being applied to practice, has given the utmost satisfaction, both in the saving of stuff and time; the diagram for the face-mould is completely divested of all cross and oblique lines, and is, perhaps, in the most simple form to which it can possibly be reduced; the plane of section comes in contact with the tops of three vertical sections of the rail in every case whatever, and thus every desideratum is obtained by the most simple means.

Therefore, in practice, if we suppose the section of the rail to be two and a quarter inches horizontally in breadth, and two inches in thickness. (as is generally the case,) a plank of two and a half inches thick will be sufficient for a rail, with any degree of concavity or convexity on the back.

L. O. F. C.

.(From Mr. Nicholson.)

Fig 1

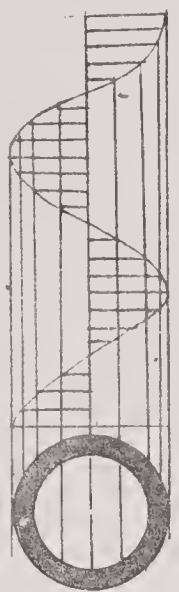
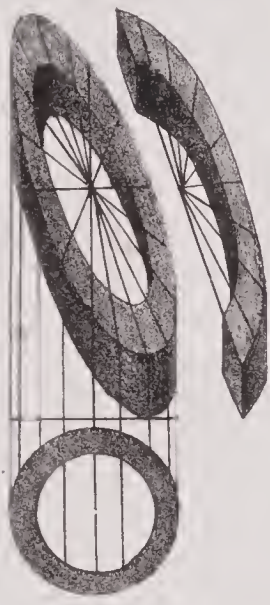


Fig 2.



Fig 3.

Nº3. Nº2



Nº1

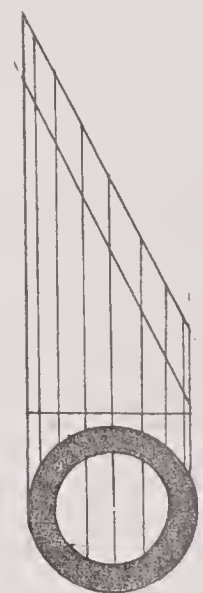


Fig. 4.

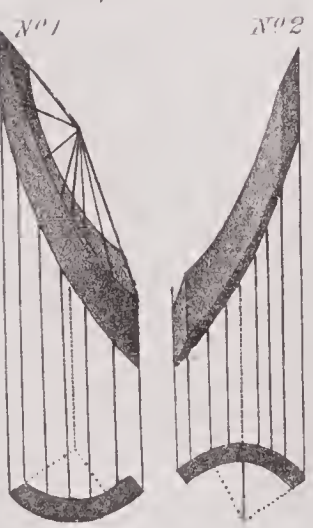
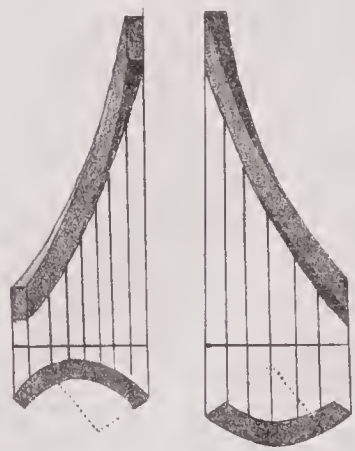


Fig. 5.

Nº1. Nº2.



We shall now proceed to the illustration of the subject by the figures which represent the solids themselves :—

Fig. 1, is a plan of the cylinder, with the elevation of the helical line, which is found by dividing the height into equal parts, and the circumference of the base into equal parts also, then drawing the lines through the points of division, as in the figure.

Fig. 2, a representation of the solid helix twisting round the cylinder, making a continued rail upon a circular plan ; the curvature of the solid helix is, therefore, every where the same. The rail is exhibited as squared ; and though it appears as one piece, it must be understood to consist of several wreaths, or lengths, screwed together, each length answering to a quadrantal part of the plan.

Fig. 3, shews the different sections of a hollow cylinder, cut entirely through the curved surface ; the solid exhibits a portion of the said cylinder contained between two parallel planes : No. 1, shews the thickness of the section according to the inclination of the cutting plane ; No. 2, shews the section of a semi-cylinder ; and No. 3, that of an entire cylinder, cut according to the position of No. 1 ; the sections No. 2, and No. 3, being turned round, so that the plane of section may be brought into view, in order to make the solid appear.

Fig. 4, exhibits a solid section of a hollow cylinder, upon a quadrantal plan, with a small part straight ; No. 1, exhibits the convex side, No. 2, the concave side. This figure shews the state of the rail-piece, as prepared by the face-mould, and is therefore bounded by two concentric cylindrical surfaces, and two parallel planes. The falling mould being applied upon the convex side, the superfluous wood is cut away according to a line drawn by the upper edge of the falling mould, in such a manner that the stock of the square, being applied upon the convex side, parallel to the axis, the under edge of the blade may coincide with the top or winding surface of the rail-piece. The thickness of the rail is regulated by running the stem of a guage first upon the convex side, with the head upon the top or winding surface, and then the stem upon the concave side in the same manner, and cutting away the superfluous stuff between the two guage lines.

Fig. 5, exhibits the wreath, or rail-piece, as completely squared ; No. 1, shews the concave side, with the lower end of the back, or upper surface, and the higher end of the lower surface ; and No. 2, the convex side of the cylindric surface, with the upper part of the back, and the lower part of the under side.

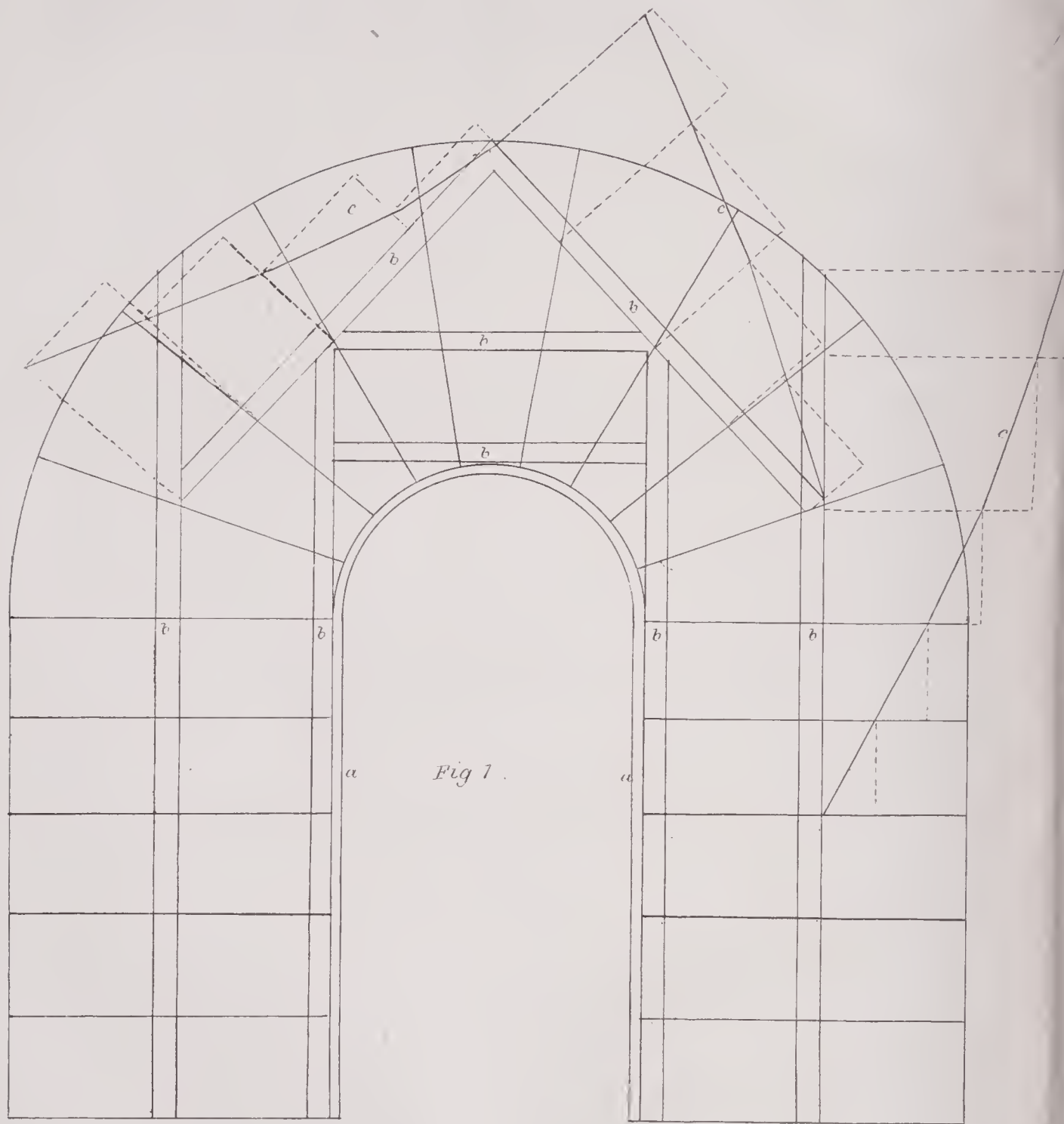
The rail exhibited in fig. 2, is only a succession of wreaths, as in fig. 5.

From what has been shewn, it will be easy to conceive how a rail may be executed to any given plan, and to any development of the steps according to that plan.

Though it may be possible to make a rail in one piece, as in fig. 3, No. 3, such a rail will hardly ever come into practice; the representations of the solid sections, in Nos. 2 and 3, are therefore not shewn with a view of being prepared for a rail, but to give a clear view of the different parts of the solid sections of a hollow cylinder.

(From Mr. Nicholson.)





PL. 15.

This Plate is introduced to explain the most ready method of construction for the framing and applying the common carriages of a winding stair-way, in which, very frequently, materials and labor are unnecessarily applied. The application and location of the several carriage pieces will be governed by the judgment of the workman. The following description will serve as a general rule, and in most instances answer with a degree of perfection.

Fig. 1, Plan of a portion of the stair, showing the different parts, as at the letters.

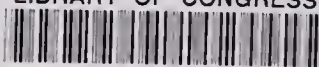
a, the front string.

b b b, &c., the plans of the common timber carriages thrown in, as most convenient for the winders, &c.

c c c, the under line of the steps and risers in the elevation of *b b b*. The dotted lines represent the steps and risers. The carriages *b b b*, are of scantling, about 4-S, and are cut off on the under side, when they may drop below the soffet or plastering of the stair.

The executor will readily perceive that a line running diagonally across the steps will vary the widths, and consequently require each one to be raised from its plan, as in *c c c* from *b b b*.

LIBRARY OF CONGRESS



0 033 266 231.4